# Lab Center – Hands-on Lab

# Session 4322

# Get Hands-on Next Generation IoT Platform

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# 1   Introduction to this lab

## 1.1   Welcome to this lab: Get Hands-on the Next Generation IoT Platform

In this hands-on lab you will learn how to get started with the next generation Watson IoT Platform and quickly take advantage of the market leading platform for Industrial IoT. You will learn about the capabilities in Watson IoT Platform and how to connect devices, create device abstractions and transformations. You will also explore and analyze the device data using the IoT Platform Analytics Service to compute data metrics and statistical KPIs.

## 1.2   About Watson IoT Platform

The IBM Watson Internet of Things Platform is a fully managed, preconfigured cloud-hosted service available in IBM Cloud providing Connection, Analytics and Blockchain services to client applications or IoT Industry solutions.

Using the IBM Watson IoT Platform you turn your device data into meaningful insights. Use these data insights to optimize your business processes and impact the future design of your products or services. Watson IoT Platform provides tools that allow you to process IoT data with both real-time and historical analytics, add "smart" capabilities the IBM Cloud to non-smart products, match appliances with customers, and securely connect your own existing apps and tools to the Watson IoT Platform infrastructure using APIs and SDKs.

Watson IoT Platform serves as a foundational capability for our industry solutions and business use cases.
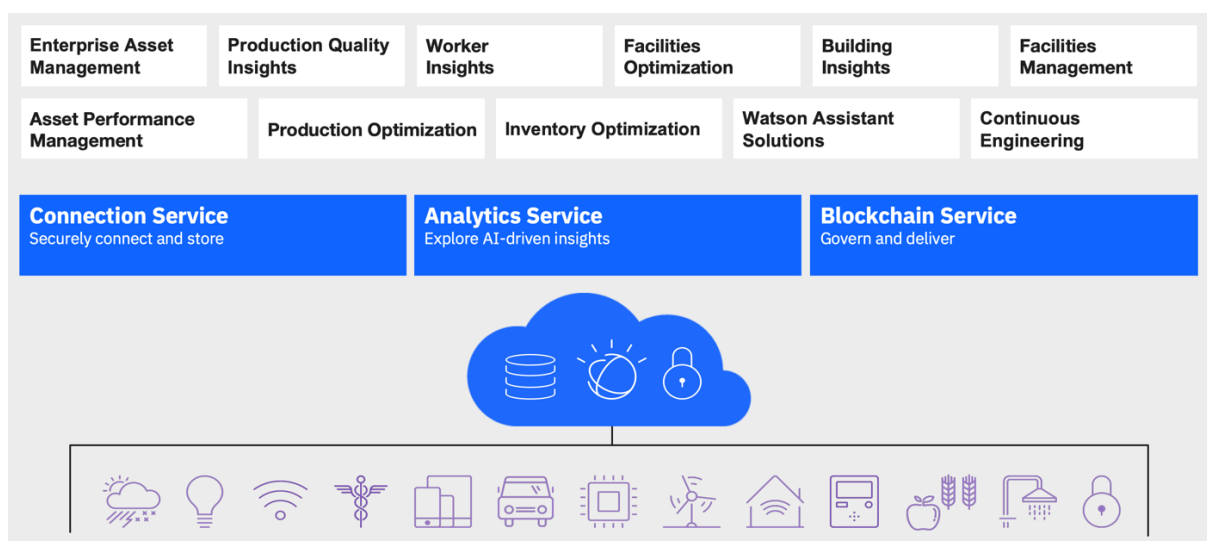
**Connectivity**

The Watson IoT Platform provides cloud connectivity to your IoT devices. Use the light-weight standardized MQTT messaging protocol to connect and start sending data securely to the IoT Platform. Use the IoT platform to access IoT data and control devices. Use IoT platform data management tools, such as device twins, to process and shape the IoT data to your needs.

**Storage**

The Watson IoT Platform provides fully-managed database components for short, medium, and long-term IoT data storage.

**Analytics**

The Watson IoT Platform provides an analytics service to perform batch scheduled analytics function on the data and implement machine learning predictive models. Choose from a range of predefined analytic operations in an extensible function catalog. Explore and define the key performance indicators for your IoT data and create alerts to respond quickly to system inefficiencies.

**Blockchain**

The Watson IoT Platform provides the IoT Blockchain Service to enable your IoT resources to participate in blockchain business networks for compliance and supply chain use cases.

## 1.3  About this lab

In this hands-on lab you will deepen your understanding and experience in the next generation Watson IoT Platform. You will use the Watson IoT Platform to gain analytics insights into the IBM Munich IoT Center.

In the first section of this lab, you will first explore the data events sent from the devices instrumenting the 27th floor in the IBM Munich IoT Center building. You will then explore the interfaces and transformation performed as data is ingested into the IoT Platform. In the second section of the lab you will continue to explore the data lake of historical data. Using the historical data, you can discover trends and notifications of events. In the third and last section of the lab you will deep-dive into the analytics capabilities in the Watson IoT Platform and explore analytics on worker safety, comfort levels, and workspace presence and utilization.

## 1.4  About Watson IoT Munich

IBM is investing over $3 billion USD to bring Watson to IoT – including $200 million USD to the new Munich IoT Center. In Munich, the Internet of Things comes of age with advanced Watson cognitive computing technologies and the world's first state-of-the-art client 'collaboratories'. With over 6,000 clients and partners and home to 1,000 IBM'ers, Watson IoT Munich is quickly becoming the center of the smart new global ecosystem.

Take a virtual tour of the Watson IoT Center in Munich at
https://www.ibm.com/internet-of-things/learn/iotcenter/

The floor plan of the Munich Twin Tower building, hosting the IBM IoT Center, is sectioned into East- and West-wing workspaces and meeting rooms. The wings are separated by the central elevator section, conference rooms, hallways and utility spaces.
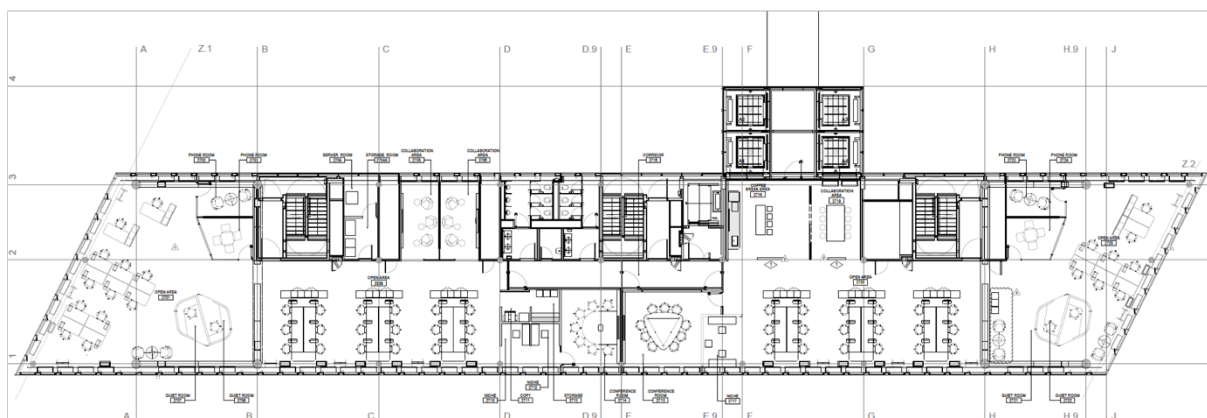
## 1.5  About Sensor Instrumentation of the 27th Floor

The IBM IoT Center in Munich has been instrumented with devices and sensors from many IBM IoT business partners. In this lab we will use devices from Yanzi Networks (www.yanzi.se) deployed to the 27th floor of the building.

Three types of devices are used:

- **Yanzi Motion** detects motion and monitors the temperature.

- **Yanzi Motion+** devices for monitoring occupancy as well as temperature, humidity, ambient light, and sampled ambient noise.

- **Yanzi Comfort** monitors air quality by measuring levels of carbon dioxide ($CO_2$) and volatile organic compounds (VOC), as well as temperature, humidity, barometric pressure and ambient noise.


The floors in the building has been instrumented to monitor worker safety, comfort levels, and workspace presence and utilization. The devices are assigned to zones representing conference rooms, utility rooms and general workspace areas. The floor plan illustration below indicates the zones in light blue and the devices deployed into each zone as colored circles. Motion type devices are shown as blue circles, devices of Motion+ type as red and devices of Comfort type as green.



Each device is assigned an Id and a Zone in Watson IoT Plartform. This metadata information is used to logically associate the device with its location and is used for analytics purposes. As an example, as shown in the illustration below, the meeting rooms zone 3 are instrumented with Motion+ and Comfort type devices.

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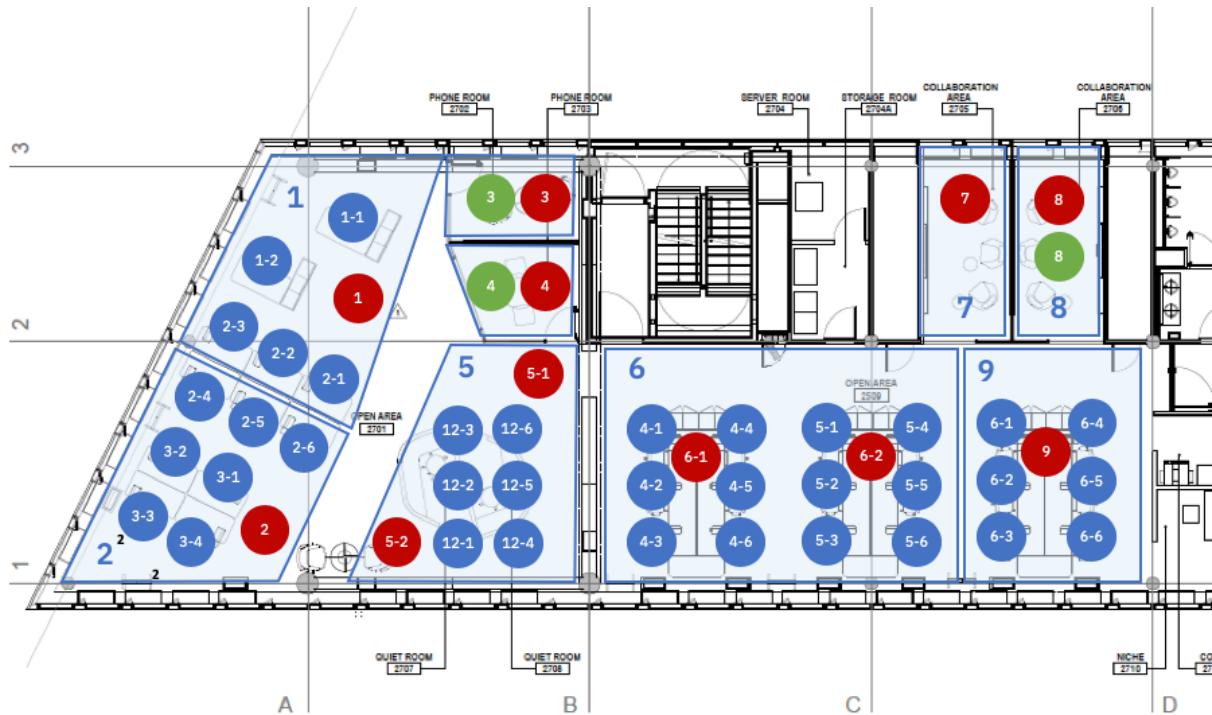
The two devices in zone 3 register several individual sensors in the Watson IoT Platform. For example, the comfort sensor with id EUI64-0080E10300045A93 is registering individual temperature, $CO_2$, Air Pressure, Sound Pressure, Humidity and Volatile Organic Compound sensors in Watson IoT Platform. The name of each sensor, of a device, takes the name of the device and adds a sensor post-fix identity to the name. See table below.

**Comfort** sensor **EUI64-0080E10300045A93** in **Floor 27, Zone 3**.

| Device id | Device Type |
| --- | --- |
| 809646_EUI64-0080E10300045A93-10 | soundPressureLevel |
| 809646_EUI64-0080E10300045A93-3 | relativeHumidity |
| 809646_EUI64-0080E10300045A93-5 | volatileOrganicCompound |
| 809646_EUI64-0080E10300045A93-4 | carbonDioxide |
| 809646_EUI64-0080E10300045A93-6 | pressure |
| 809646_EUI64-0080E10300045A93-3 | temperatureK |

**Motion+** sensor **EUI64-0080E10300045266** in **Floor 27, Zone 3**.

| Device id | Device Type |
| --- | --- |
| 809646_EUI64-0080E10300045266-5 | illuminance |
| 809646_EUI64-0080E10300045266-10 | soundPressureLevel |
| 809646_EUI64-0080E10300045266-3 | temperatureK |
| 809646_EUI64-0080E10300045266-4 | motion |
| 809646_EUI64-0080E10300045266-3 | relativeHumidity |

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Using the sensor values from these two devices the IoT Platform can compute metrics and KPIs for the meeting room 3 on floor 27, like $CO_2$ levels, occupancy and utilization.

Similarity for workspaces, the occupancy of a single desk can be provided using the deployed motion sensors in the zone, for example sensors 1-1, 1.2 and 2-1 to 1-3. The occupancy and utilization of a zone can then be computed by analyzing the sensor values.

Comfort levels can be computed from temperature, humidity, CO2 levels, light intensity and noise levels. For worker safety regulatory purposes, the office may be monitored ensuring that the comfort levels of temperature, humidity and noise are within compliant levels and that alerts are notifying of $CO_2$ levels outside of regulatory bounds.

Using the data produced by IoT platform analytics IoT Industry Solution, like IBM Tririga Building Insights, can implement business logic and integrations to the IoT data. The illustration below shows a concept design on visualizing comfort data analytics using the derived IoT data.
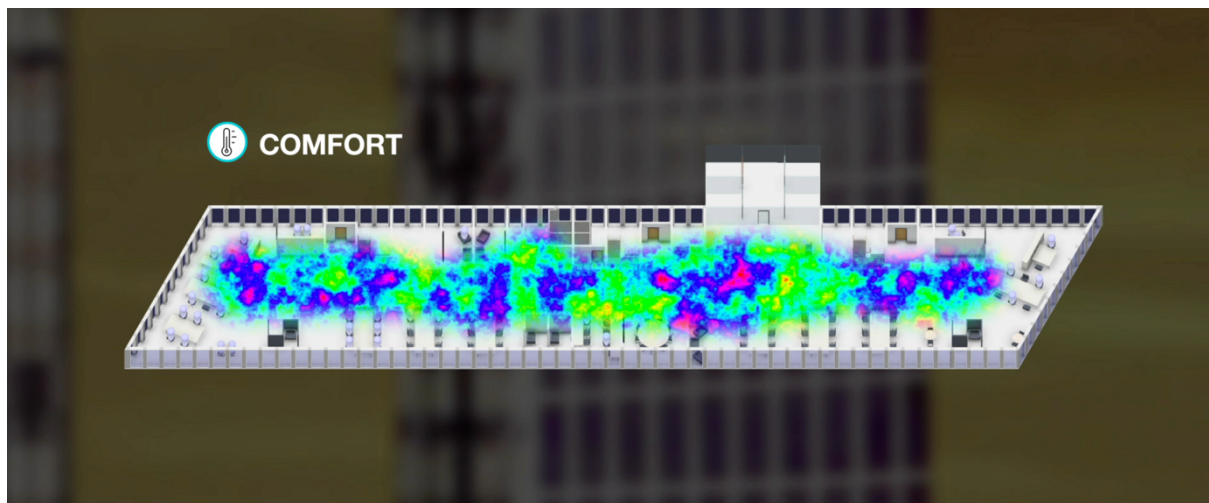


With this brief introduction we are now ready to start the lab and explore the Watson IoT Platform.

# 2 Getting started

## 2.1 Starting your Workstation

In this lab you will use a Windows 7 workstation. This workstation is only used to run your web browser providing you access to IBM Watson IoT Platform on IBM Cloud. At the start of this lab, all workstations should have been started and ready for you to use with automatic login.

**Note**: If you fail to log into your workstation, ask your lab facilitators for help.

## 2.2 Logging into Watson IoT Platform

IBM Cloud, previously named Bluemix, is a cloud platform as a service (PaaS) developed by IBM. It supports several programming languages and services as well as integrated DevOps to build, run, deploy and manage applications on the cloud. IBM Cloud is based on Cloud Foundry open technology and runs on SoftLayer infrastructure.

In this lab you will use the Watson IoT Platform and the services running in IBM Cloud. All attendees in this lab will use a shared Watson IoT Platform and the corresponding Watson IoT platform service organization across all lab workstations.

To log into the Watson IoT Platform.

1. Open the Firefox browser on your workstation

2. Enter the tenant URL http://ibm.biz/thinkiotplatform.

   Or use the full tenant URL https://dashboard-us.connectedproducts.internetofthings.ibmcloud.com/preauth?tenantid=Think-2019

3. The Watson IoT Platform login page opens

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4. Click on **Log in to Think-2019**

5. Enter the IBM ID "thinkiot@mail.com"
   Enter the password "think2019iot"

6. Click **Log in**

7. The Watson IoT Platform Welcome Page is loaded.



You have now successfully launched and logged into the IBM Watson IoT Platform.

## 2.3  Overview of the Watson IoT Platform

The Watson IoT Platform welcome page presents the main capability sections:

- The **Connect and collect** section launches the Watson IoT Platform Service used to connect and manage devices.

- The **Explore and analyze** section provides access to the data lake and Entity time series data

- The **Usage** section provides access to the preconfigured services for messaging and data storage.

- The **Users** section provides control of users and permissions.



In the sections of this lab we will in-depth explore the usage of the Connect and Explore sections in Watson IoT Platform. In the last section of this lab we will also overview the capabilities for IoT platform administration and user management.
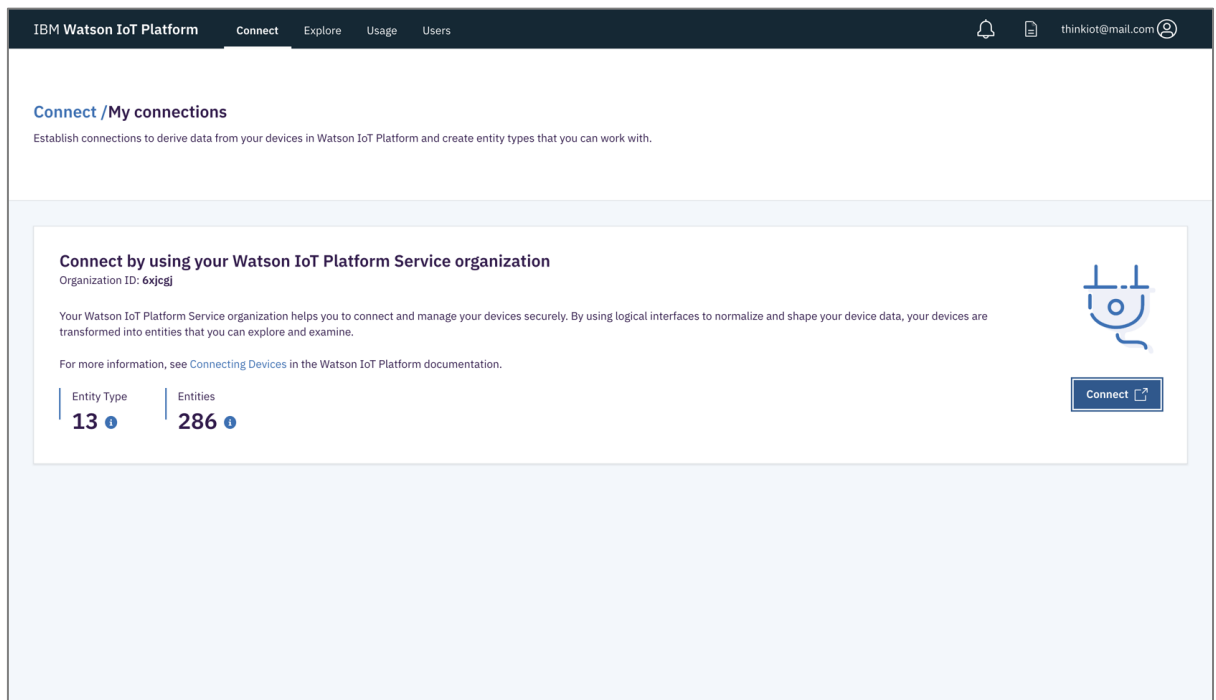
# 3   Overview of the Watson IoT Platform Service

We are now ready to launch the IoT Platform Service, used in this lab to view device connections and events.
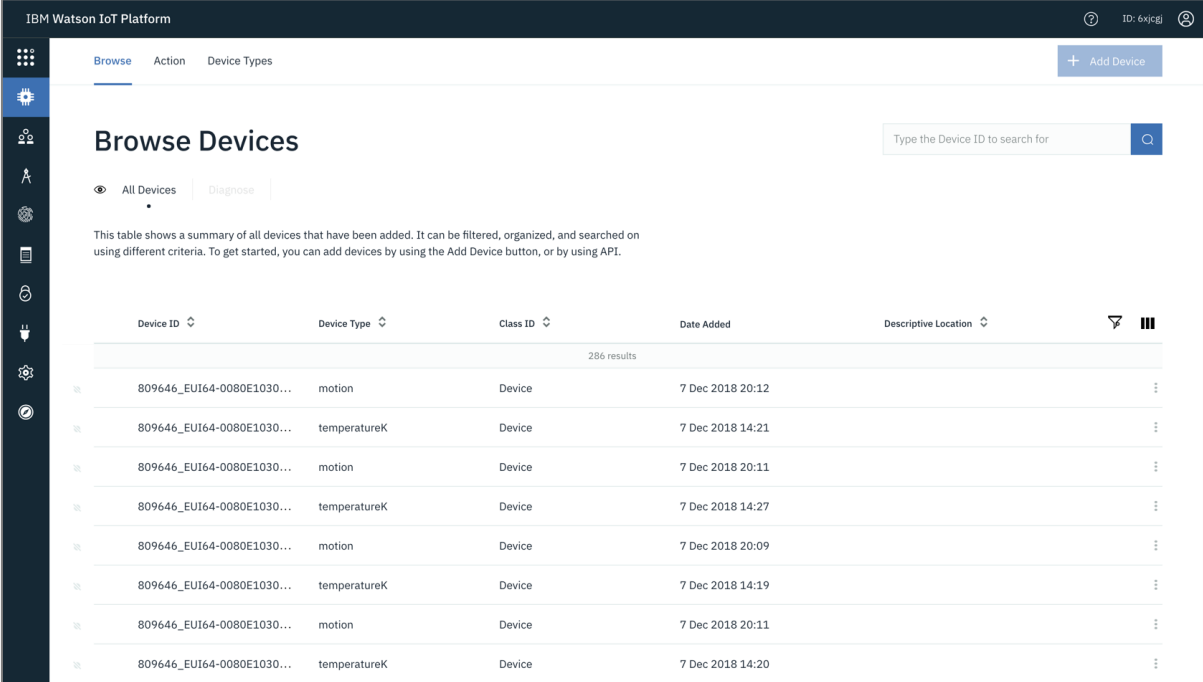
Watson IoT Platform Service is preconfigured part of the Watson IoT Platform. This is the service where you define, register and manage your connected devices. Each Watson IoT Platform service, or *organization*, is given a unique six-character organization ID. Watson IoT Platform Organizations ensure that your connections and data are securely organized and accessible only to your devices, cloud services and business applications. In this lab we will use organization ID: **6xjcgj**.

To open the Watson IoT Platform service

1.  Select the **Connect** section on the Watson IoT Platform banner.
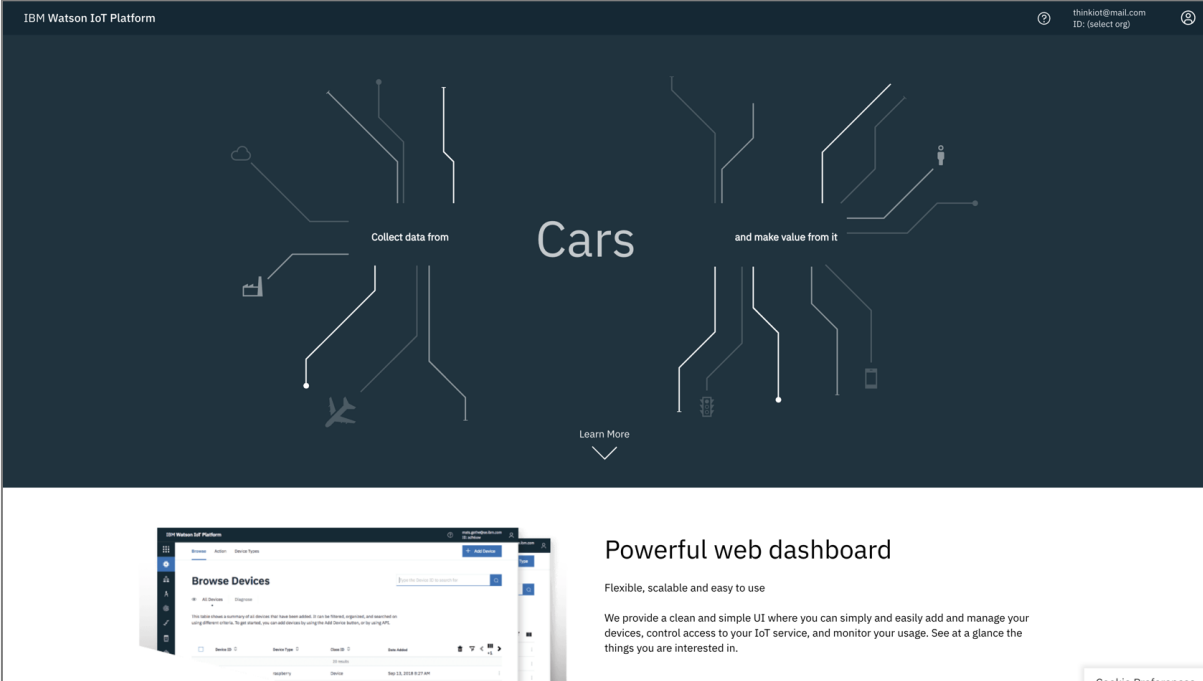2.  The Connect page opens

3. On the Connect page, click on the **Connect** button to launch the Watson IoT Platform Service.

4. The Watson IoT Platform Service opens in a new browser tab



5. **Note**, in some cases the Watson IoT Platform Service do not open with the organization 6xjcgj selected, as shown below.

6. Click on the organization switcher menu on the top right and choose "**Think IoT 2019 (ID 6xjcgj)**" from the menu.
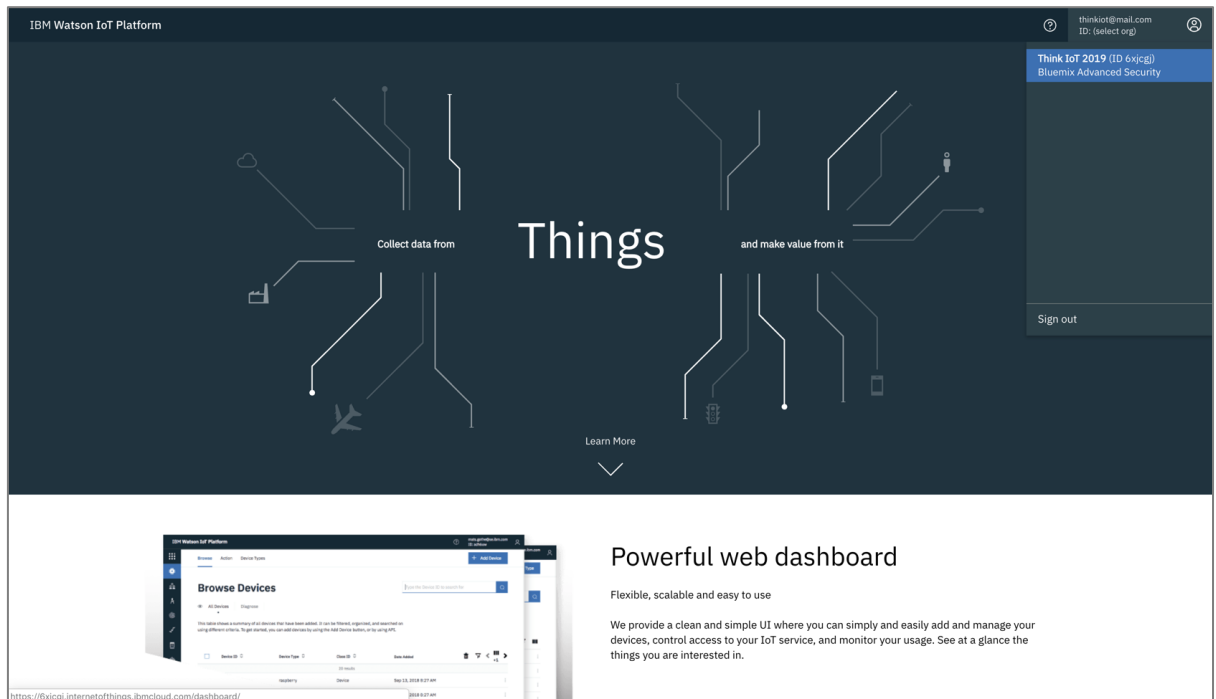


**Note**: By selecting the organization id in the switcher menu, the page will reload and show the selected IoT Platform Service organization.
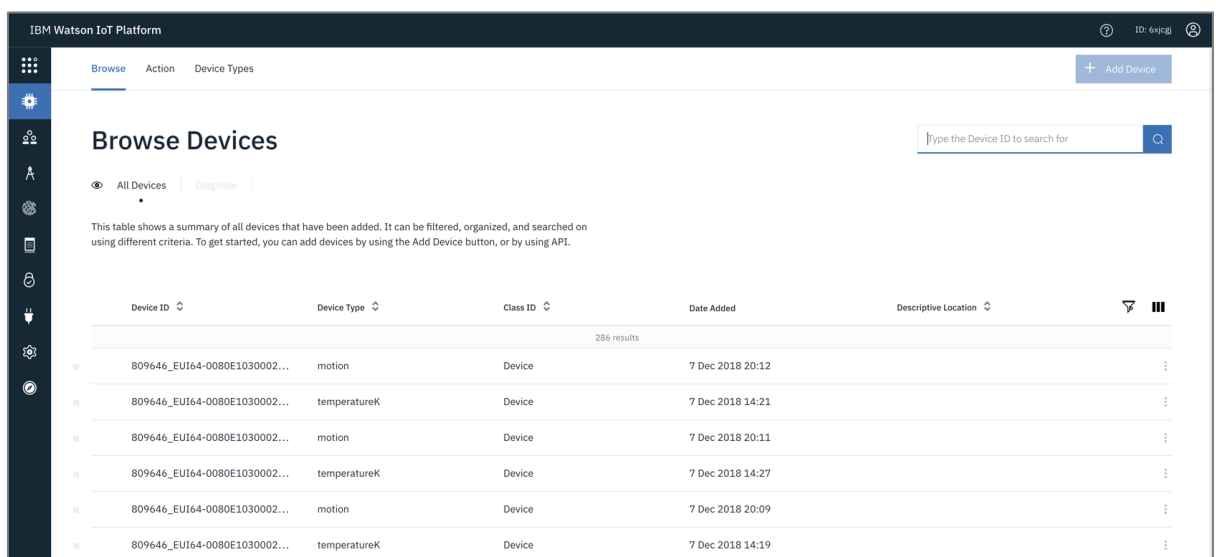


You have now successfully launched the Watson IoT Platform Service organization that we will use in this lab.

## 3.1 IoT Platform Navigation

IBM Watson IoT Platform Service provides a powerful web application for operators, administrators  and developers with secure access to IoT devices and device data. In this section of the lab you will familiarize yourself with the IBM Watson IoT Platform Service user interface.

The navigation bar on the left-hand side provides access to the capabilities of the IoT platform service.



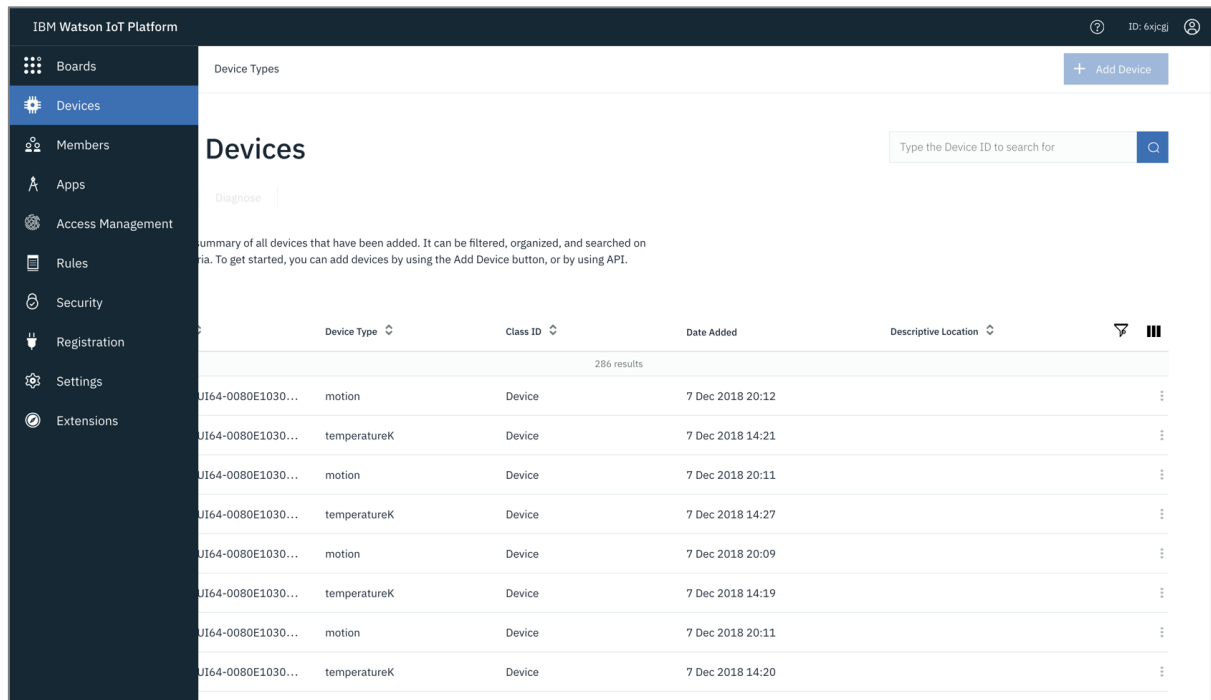The IoT platform navigation sections are

- **Boards** – Opens the dashboard and shows the boards and cards
- **Devices** – Opens a browser for registered devices and their device types
- **Members** – User management
- **Apps** – API Key management
- **Access Management** – Roles and Permissions
- **Usage** – Metrics of usage
- **Rules** – Analytics rules and actions
- **Security** – Risk and Security Policies
- **Settings** – Administration settings. For example, client and server certificates.
- **Extensions** – Additional capabilities, optionally enabled

## 3.2  Exploring Device Types

*Devices* are things, like smart physical sensors and actuators, that connect to the IoT platform over internet. The Watson IoT Platform Service helps you define and manage your devices. Devices of the same type, brand, make or model are of a *Device Type*.

To view the Device Types registered in the IoT platform service

1.  Move your mouse pointer to the left side navigation bar. The navigation bar slides out and shows the IoT platform capability sections.

2.  In the navigation bar, choose **Devices**.



3.  The Devices page opens. This view shows all devices registered in this organization.

4. On the Device page, choose the **Device Types** tab.

5. The Device Types page opens.
   This page shows all device types registered in this organization.



**Note**: The Device and Device Type pages provides a list of existing resources in the IoT Platform. Using the **+ Add Device Type** and **+ Add Device** buttons, new devices and types can be added to the IoT platform.

In this lab we will use the devices deployed at the IBM Munich IoT Center. There are several device types of devices. Viewing the device types page, we see a summary of the device types and the number of devices registered of each type, for example

- Carbon Dioxide sensors
- Air Pressure sensors
- Relative Humidity sensors
- Sound Pressure Level sensors
- Motion sensors
- Temperature sensors

We will later in the section return to this page and explore more details on the data transformation performed by the IoT platform for these device types.

## 3.3  Exploring Devices

Devices are the physical sensors and actuators that connect to the IoT platform over internet. The Watson IoT Platform Service helps you define and manage your devices and ensures a secure connection for transferring data from the device to the cloud.

To view devices registered in the IoT platform organization

1. Move your mouse pointer to the left side navigation bar.
   The navigation bar slides out and shows the IoT platform capability sections.

2. In the navigation bar, choose **Devices**.



3. The Devices page opens. This view shows all devices registered in this organization.



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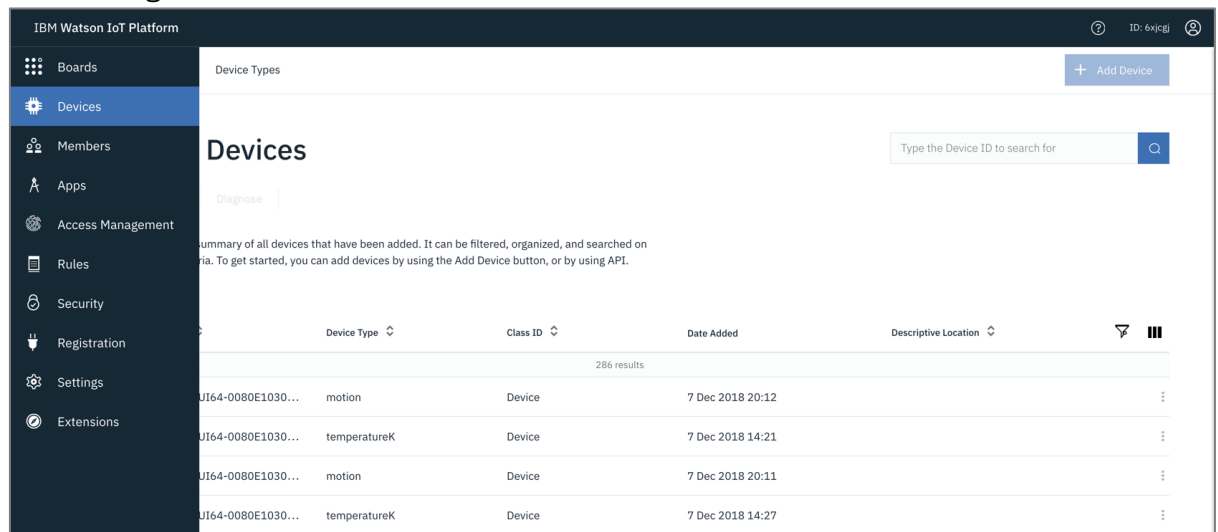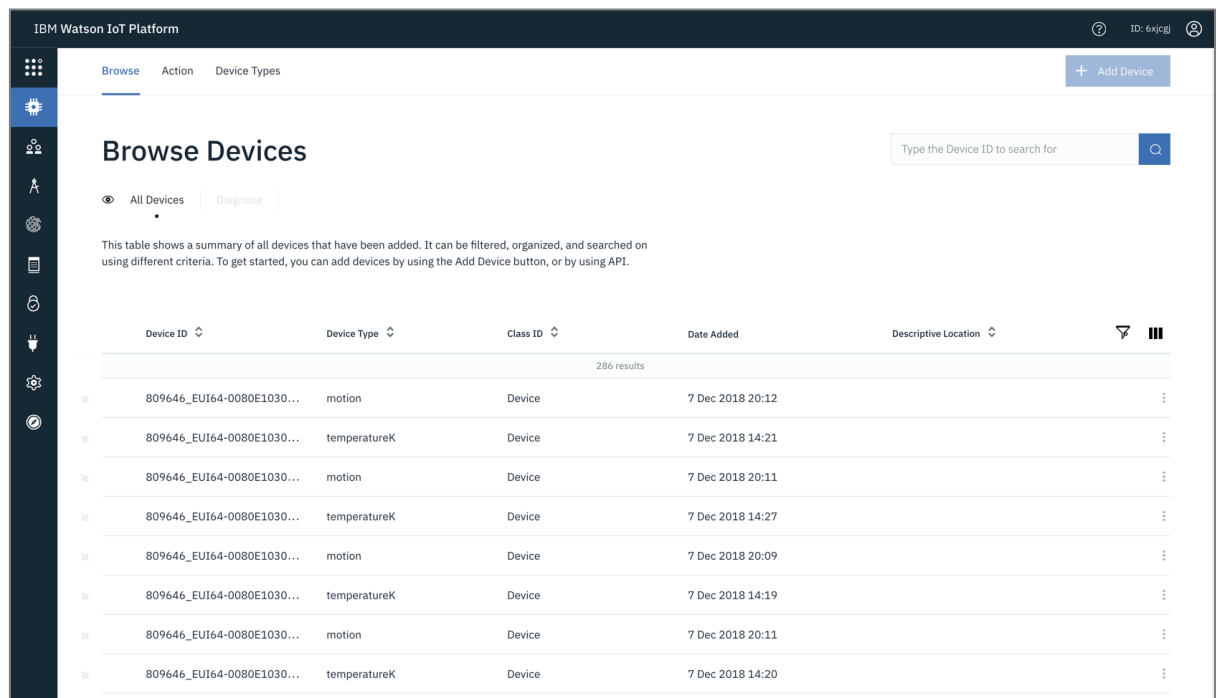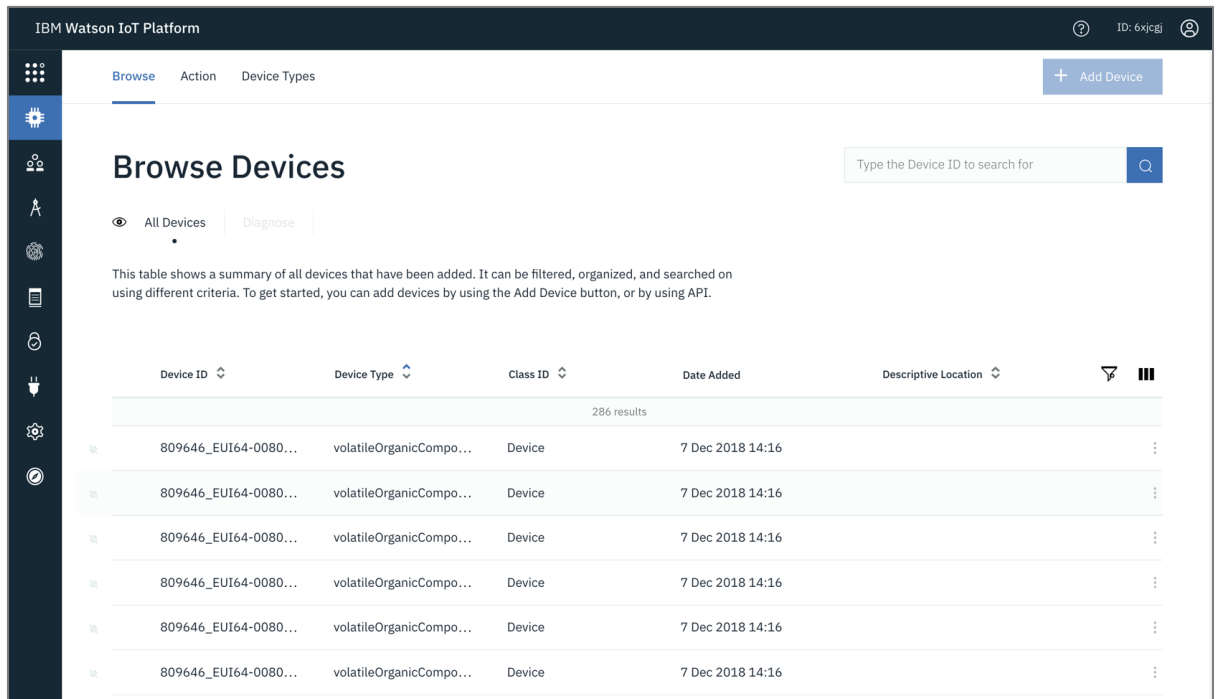
4. The Devices are by default sorted by the Device ID column. Use the sort icon to sort the devices by any column.
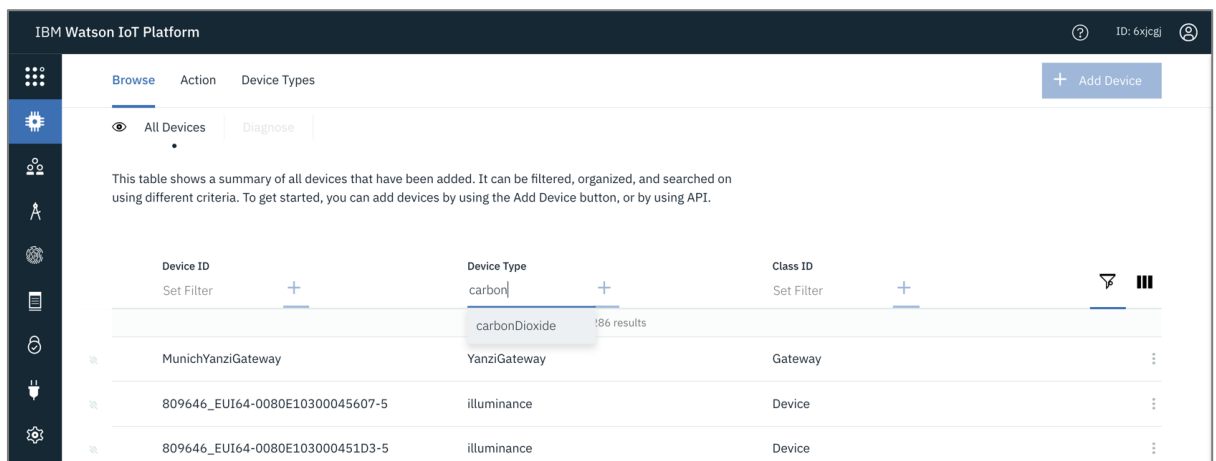
   Click on the Device Type column sort icon ⌄ to sort devices by type.



5. A filter may be applied to find a specific set of devices, for example of a single type or using a common name pattern.

   Click on the filter icon ▽ , type "carbon" in the Device Type filter and select carbonDioxid in the auto-complete menu.



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6. The Device table applies the filter and only shows the carbonDioxide sensors.



7. To filter devices by floor or zone, apply the filter "zone 3" to the descriptive location column.



8. Click on the filter icon ▽ to disable filtering.

The device table has a Search function that quickly finds matching devices by name.
To find a device, or a group of devices

1. Enter a search string into the quick search field.

   Type a full device id, like "809646_EUI64-0080E10300045A93-3", or just a part of the name, like "93-4"

2. The carbon dioxide sensor 809646_EUI64-0080E10300045A93-4 is found and shown in the list

## 3.4  Exploring Events

*Events* is the mechanism by which devices publish data at a regular heartbeat to the Watson IoT Platform. The frequency is decided by the device, for example every second, every minute, every hour, or once a day. The device controls the content, or *payload*, of the event. Similar events are defined as an *Event Type*. and the payload data structure of the event type is defined by a schema. Events can be published in different formats, for example, JSON, string, binary, and more. By default, the Watson IoT Platform expects events in JSON format specified by a JSON schema.

To view events sent by a device

1.  Choose a device in the device table, for example the temperature sensor 809646_EUI64-0080E10300045A93-3. ( ID 3 in Zone 3)

    Clicking on the device row in the table will show more details on the device

2. Choose the **Recent Events** tab



**Note**: The screen does not at first show any events. Wait a minute for the next event sent from the device to show.

3. Newly received events from the device are shown in the recent events list.



4. Click on an event in the recent event list to view the event payload.

The JSON payload is shown with Value and Time data.
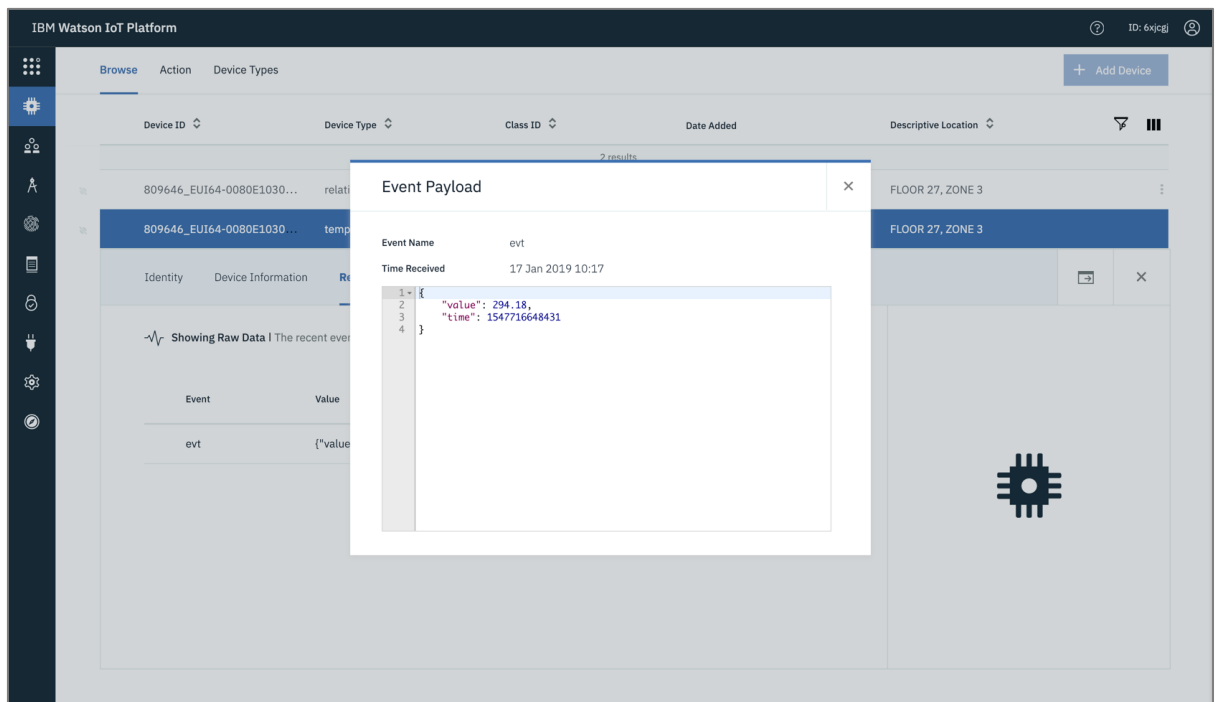
**Note:** The data payload from a temperatureK sensor has a *Value* element that contains the temperature level expressed in Kelvin degrees. The Kelvin temperature scale uses the absolute zero (0 K) as is equivalent to −273.15 °C or −459.67 °F. The *Time* element is the time-stamp when the value sample was taken.

## 3.5  Exploring Device State

The Watson IoT Platform provides transformation and normalization event data into a single logical view called *device state*. This feature greatly simplifies application development as applications can rely on a common interface abstraction and be independent of device event type schema variations across devices of different versions, variants and brands.

To view the device state of a temperature sensor

1. Choose a device in the device table, for example the previously explored temperature sensor 809646_EUI64-0080E10300045A93-3.

2. Choose the **State** tab.

    The current state of the selected temperature sensor is shown.

**Note:** By default, the Raw Data interface is shown. Note that these are the data items delivered in the device event. Also note the Last Received property that indicated the time period since this event was received.

3. From the Interface drop down, choose the **TemperatureK_LI** interface.



The table now shows a normalized of the temperature sensor, including the raw event data items, value and time, and the temperature transformed to Celsius, Fahrenheit and Kelvin temperatures. The interface also concludes a comfort level value. We will return to the analysis of comfort levels in an later section.

These data transformations are defined on the Device Type and apply to all devices of the type.
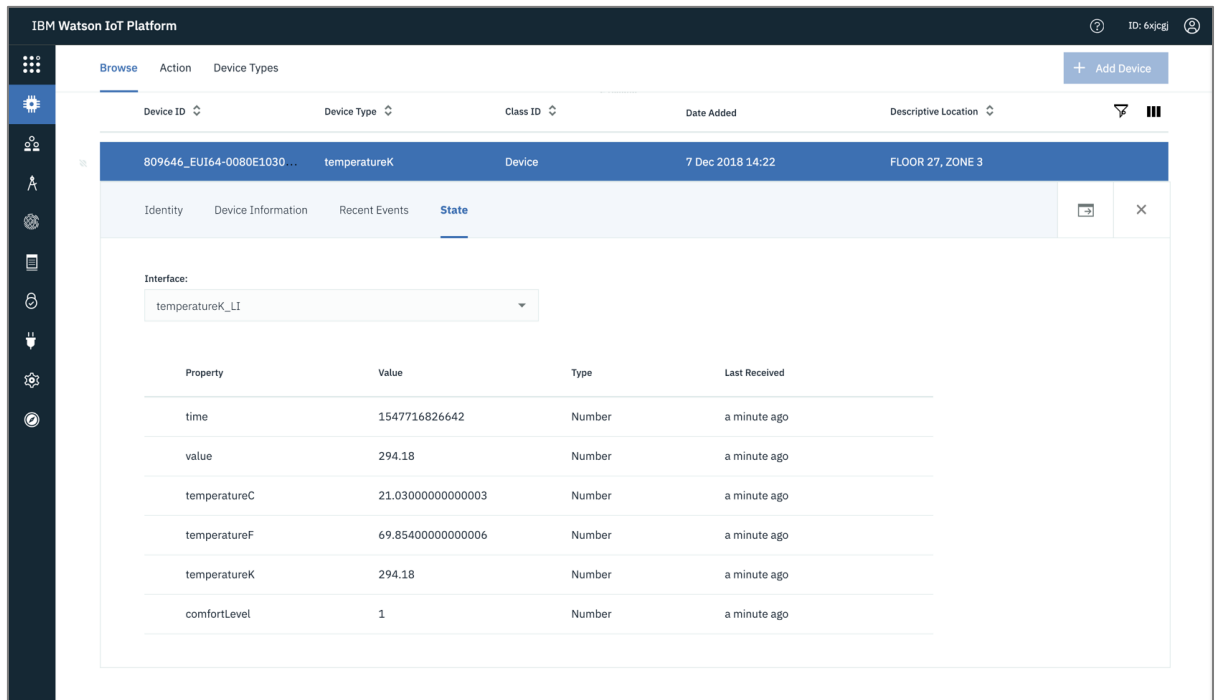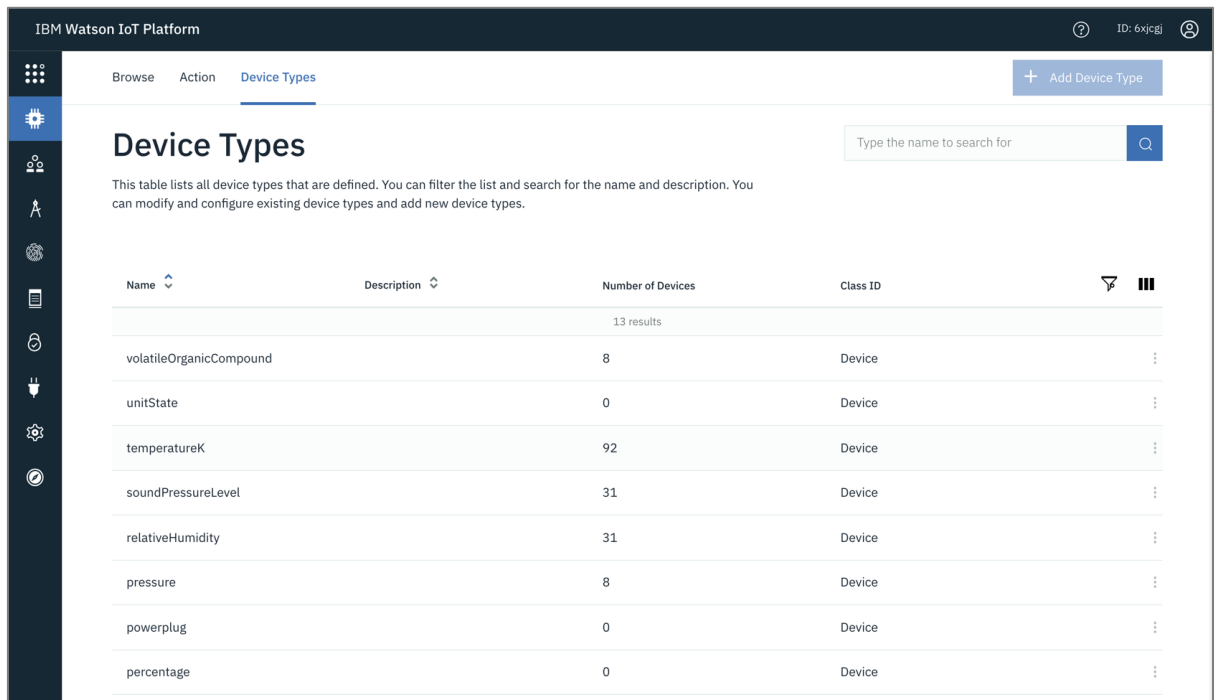
By using an interface, devices of a type may provide a common abstraction with defined data names and values. An application can trust that any temperature sensor type will provide a Celsius, Fahrenheit and Kelvin temperature regardless of its event types and payload data structures.

4. Select devices of other types to explore their data items, JOSN payload structures and interface definitions. For example,

- The **motion** device type that defines isOccupied and lastOccupied properties for workspace occupancy.
- The **soundPressueLevel**, **relativeHumidity** and **carbonDioxid** device types that each defines a comfortLevel property based on sensor values and regulated office comfort levels.

## 3.6 Exploring Interfaces

To view *device types* registered in the IoT platform service

1. In the navigation bar, choose **Devices**.

2. On the Devices section, choose the **Device Type** tab



3. In the Device Type list, select the "temperatureK" device type.

4. Select the **Interface** tab.

   The interface tab shows the interfaces defined for the type.

The Watson IoT Platform uses two types of interfaces for filtering, normalizing, transforming and abstracting event data into a device state.

- temperature_PI – *Physical Interface* – A physical interface represents the event types that a device of a particular device type can send. Events types not included in the physical interface will be filtered and discarded by the IoT platform

- temperatureK_LI – A *Logical Interface* represents the state of a device. It's a canonical view which can be shared across multiple device types.

- A device type also provides *mapping expressions* that computes the state in the logical interface from received events declared in the physical interface.

5. Click on the view icon 👁 to explore the temperature_PI physical interface.

   The physical interface editor opens on the Identity page
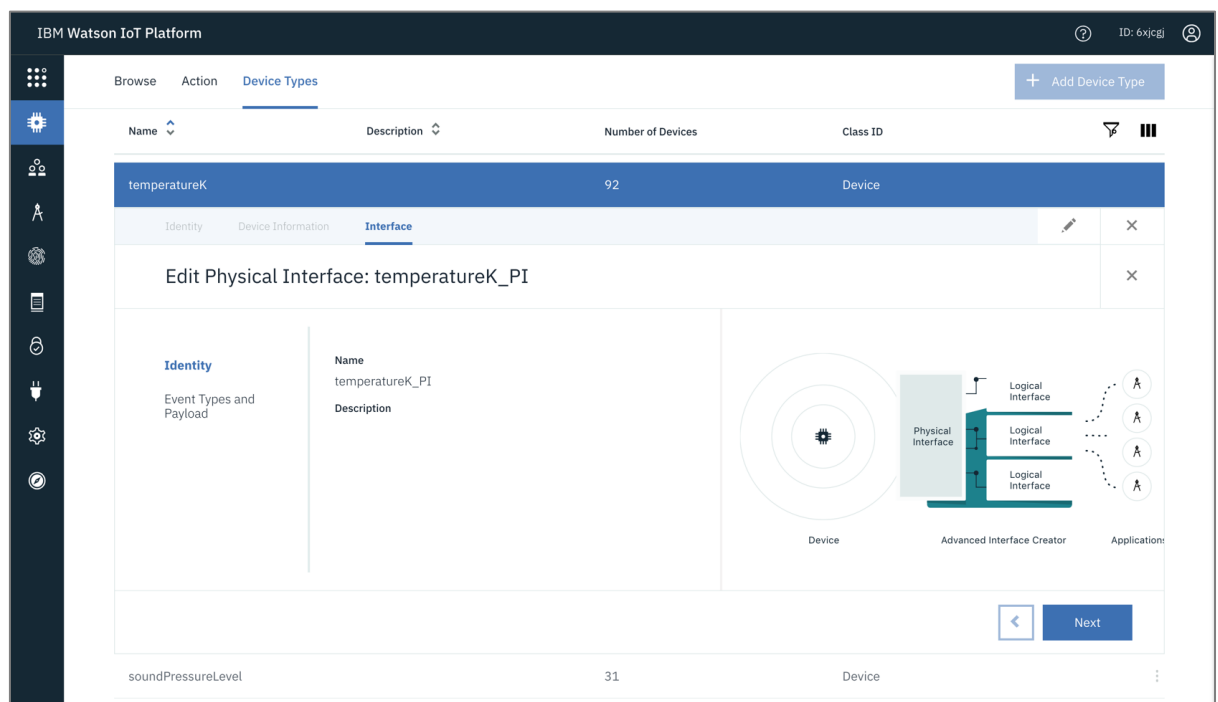


6. Click **Next**. The Event Types and Payload page opens.

7. In the Event Types list, expand the **evt** event type to view its event properties



**Note:** The evt event type with the value and time properties are the event that we explored in the previous sections of this lab.

8. Click **Done** to close the physical interface editor and return to the Interface tab.

9. Click on the view icon 👁 to explore the temperature_LI logical interface

The logical interface editor opens with the Identity page.

10. Click **Next**. The State Model page opens.



**Note:** The properties in the list corresponds to the state properties we previously explored in the temperatureK device state.

11. Click on the view icon 👁 on the temperatureK row to explore the expression computing the Kelvin temperature value.



**Note**: The temperatureK expression is just returning the value property from the evt event.

12. Close the dialog and view the expression for temperatureC.
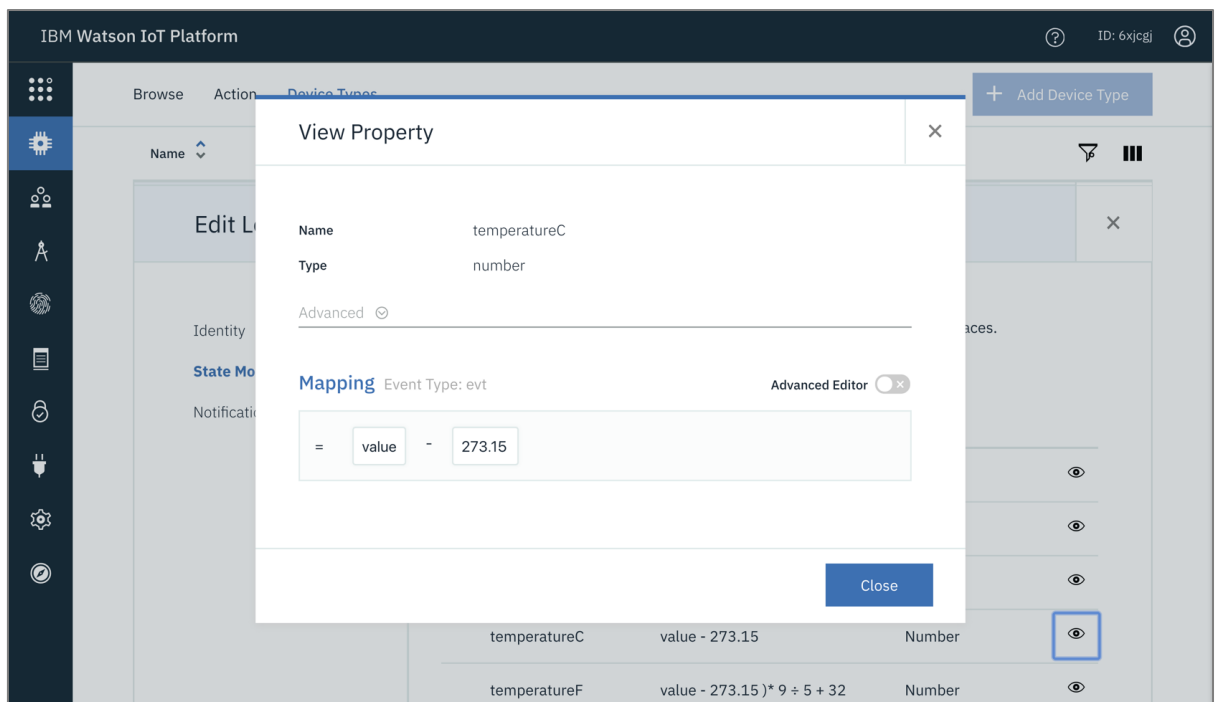


**Note**: The temperatureC expression is computing the Celsius temperature by subtracting -273.15 from the Kelvin value.

13. Close the dialog and view the expression for temperatureF.
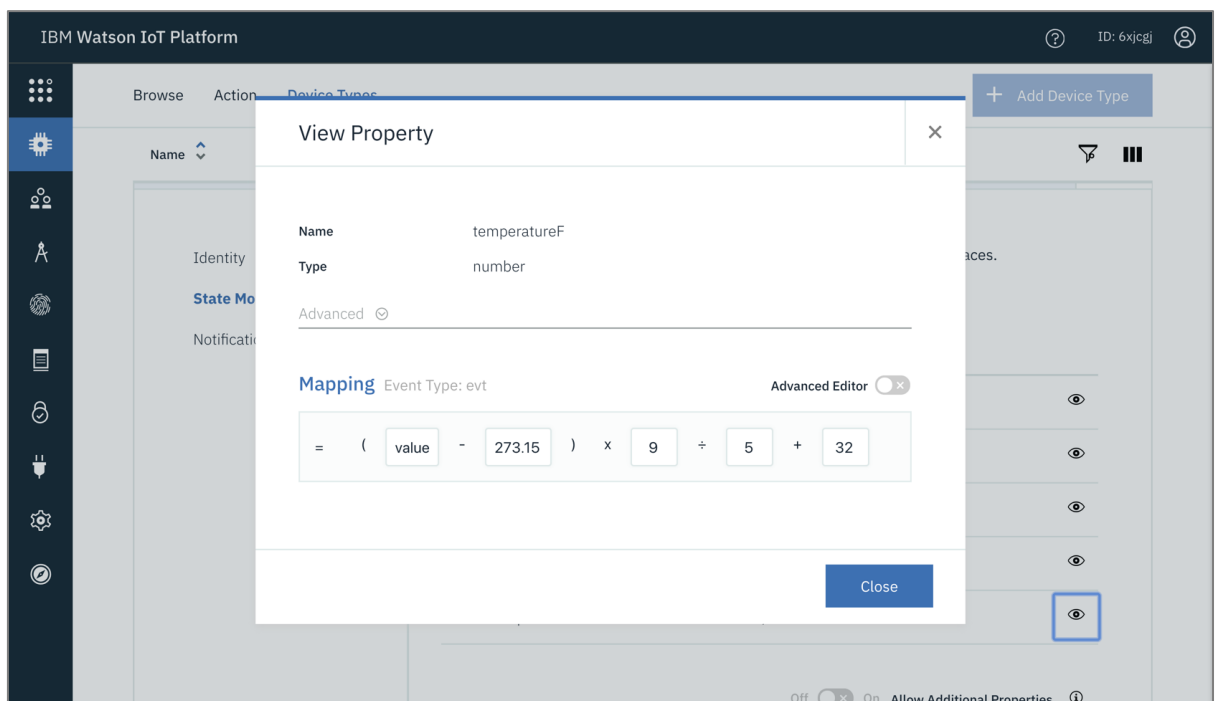


**Note**: The temperatureF expression is computing the Fahrenheit temperature by subtracting -273.15, multiplying by 9/5 and adding 32 to the Kelvin value.

14. Close the dialog and view the expression for comfortLevel.
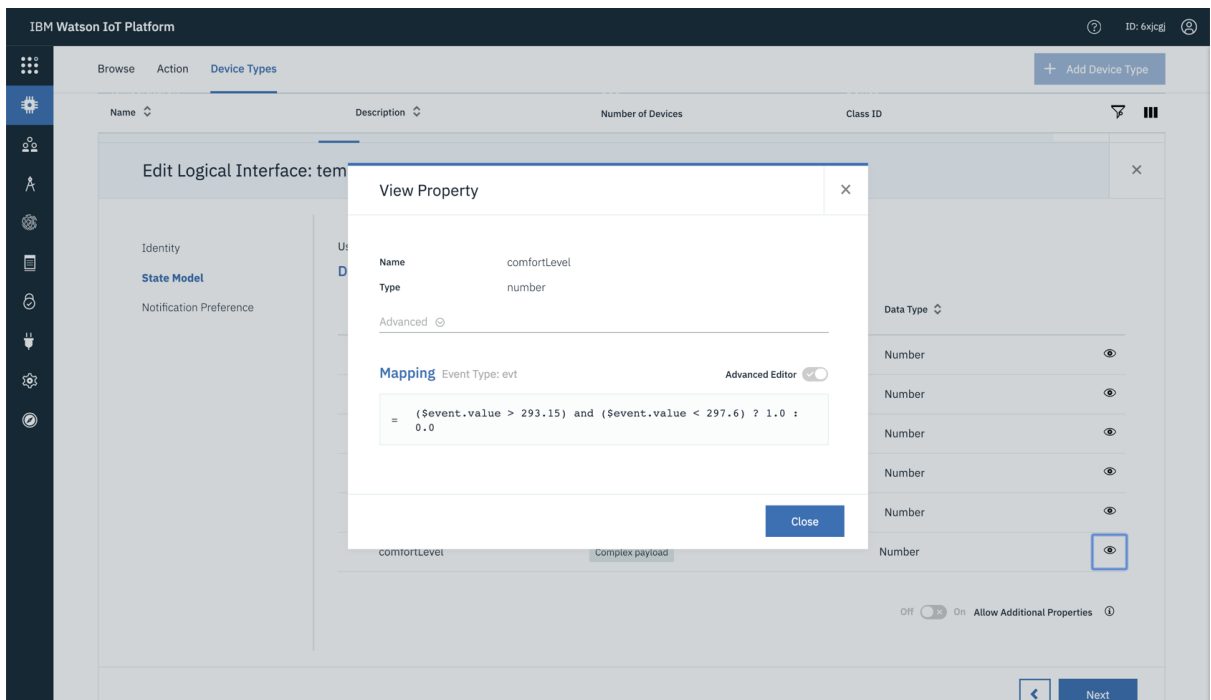


**Note**: The confortLevel is a conditional expression that return a 100% comfort if the Kelvin temperature is within the 293.15 to 297.6 range (68-76 degrees Fahrenheit). The function will return 1.0 (100%) if the temperature is comfortable, 0.0 (0%) if the temperature is uncomfortable. We will in a later section see how analytics are applied to such comfort levels.

## 3.7  Exploring Other Device Types

We have now explored the Device Types and Devices views in Watson IoT Platform Service and learned how to view, filter and search @scale across connected devices. We explored the event data from the temperature devices and the transformations performed by the Watson IoT Platform using interfaces and mapping expressions.

Before completing this section of the lab, you can proceed and explore some of the other devices and device types connected to the IoT platform.

For example

- Carbon Dioxide sensors that measures the concentration of $CO_2$ in PPM (parts per million)
- Pressure sensors that measure the air pressure in Pa (Pasqual)
- Relative Humidity sensors that measure the humidity in %
- Sound Pressure Level sensors that measure the noise level in mBA (milli Bell A-rated)
- Motion sensors that measure movement and provide a value for timeLastMotion

Explore the logical interfaces for the device types, for example,

- The **motion** device type that defines isOccupied and lastOccupied properties for workspace occupancy.
- The **soundPressueLevel**, **relativeHumidity** and **carbonDioxid** device types that each defines a comfortLevel property based on sensor values and regulated office comfort levels.

You have now completed the exploration of the Watson IoT Platform Service.

# 4  Exploring the Watson IoT Platform Connection Service

The Watson IoT Platform includes a powerful set of tools to leverage the data that you ingested from your devices. By using the Watson IoT Platform Connection Service and Analytics Service, you can run analytics in real time as data is available and stored in Db2® Warehouse on Cloud. The Watson IoT Platform Analytics in an optional, built-in analytics tools that we will explore in the next section of this lab.

The connection service, in Watson IoT Platform includes

- **Watson IoT Platform Service** (explored in the previous section of this lab)
- **Event Streams**. The Event Streams service is a high-performance messaging service that lets your applications receive device messaging from Watson IoT Platform Service close to real time. The Event Streams service is used to consume IoT device data in time-critical applications such as real-time analytics and live data dashboards.
- **Db2 Warehouse on Cloud**. The Db2 Warehouse data component provides intermediate length storage of IoT data. Db2 Warehouse on Cloud also includes a set of powerful tools to analyze that data. Db2 Warehouse on Cloud also makes up the data lake which is used as input for the analytics service. Watson IoT Platform Analytics writes function output to the data lake.
- **Cloudant NoSQL DB** - The Cloudant NoSQL DB stores the entire IoT data set in one database for all connected device types. The Cloudant NoSQL DB API can be used to extract the IoT data needed, or for integrations with IoT business applications.
- **Cloud Object Storage**. The Object Storage stores the entire Watson IoT Platform IoT data set in day-sized JSON objects for all connected device types.

All services in Watson IoT Platform are provisioned and pre-configured in a Watson IoT Platform *tenant*. In the previous section of this lab we logged into **Think-2019** tenant of the Watson IoT Platform. The tenant name is also shown in the top-right corner of the Watson IoT Platform dashboard.

We will now explore the device data streaming from the Watson IoT Platform service, through the Event Streams service, into the data lake in Db2 Warehouse.

## 4.1  Exploring Entity Type Data

Return to the web browser tab with the Watson IoT Platform.

Alternatively, repeat the steps in the previous section to log into the platform using the tenant URL http://ibm.biz/thinkiotplatform, or the full tenant URL https://dashboard-us.connectedproducts.internetofthings.ibmcloud.com/preauth?tenantid=Think-2019
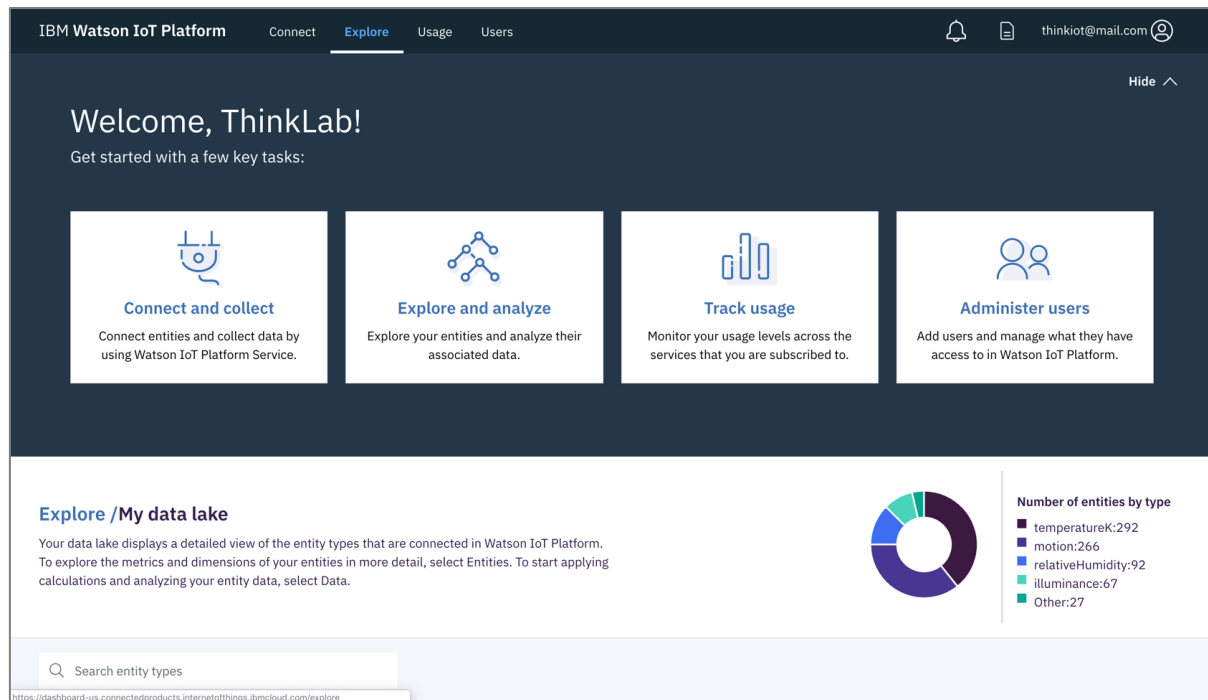


*Entities* are the digital representation of items in your IoT solution that either produce data, or that you would like to track by using data. In typical cases, like in this lab, Entities are the devices registered in the Watson IoT Platform Service.

The Data Lake in the Connection Service is organized around Entities and their time-series data from corresponding devices. Each entity takes its name from the corresponding Device. An Entity is of an *Entity Type,* corresponding to the Device Type.

Entities can be monitored by *metrics,* such as temperature, humidity, weight, or load. These metrics can be calculated to produce new and useful data. Entities can also have additional data attributed to them as dimensions.

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To view the Entities Types in the Watson IoT Platform Data Lake

1. Choose the **Explore** tab on the Watson IoT Platform banner.
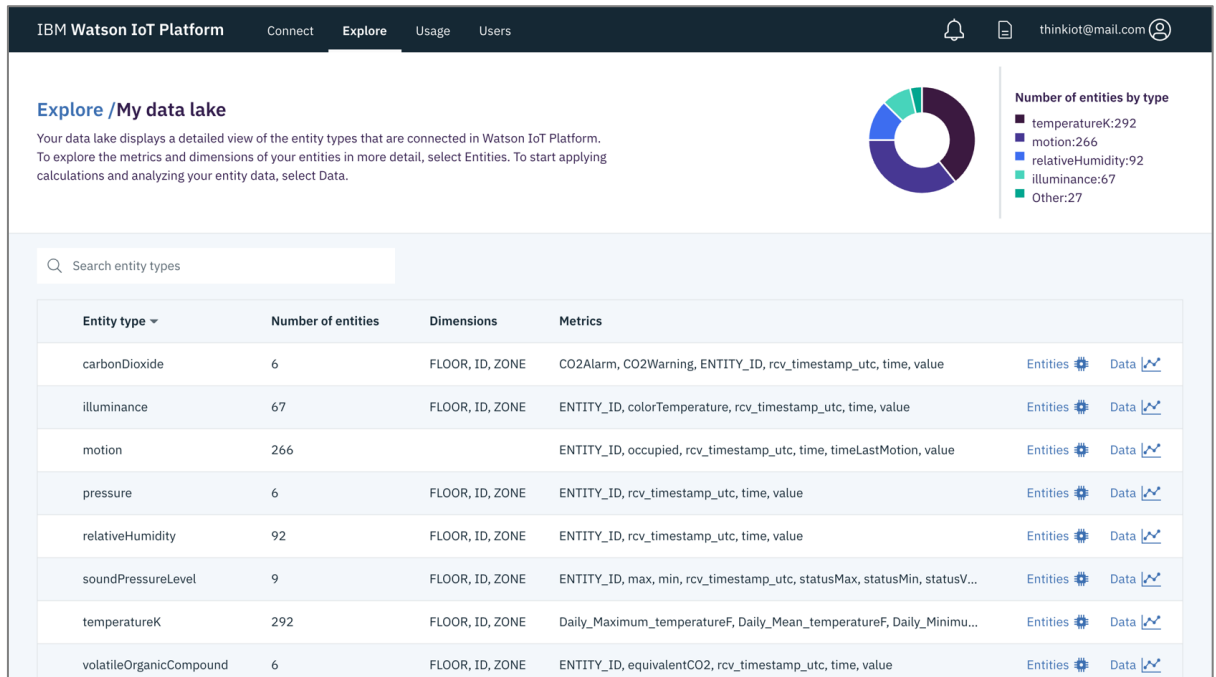


**Note**: The list shows the Entity Types, the number of Entities of each type and the metrics in the data lake of each type.

*Metrics* are data items derived from the properties of the Logical Interface and hence the device state. The state properties of a device are expected to vary, as will the metric values on an entity.

*Dimensions* are typically static values that do not change over time. For example, a dimension might be the equipment's manufacturer, location, or an associated customer. Some dimensions are subject to change, for example, the operator of a piece of equipment can vary from one day to the next. In this lab we will use dimensions to holds metadata like ID, Floor and Zone for the sensors in the IoT Center in Munich.

Each entity type row provides two navigation buttons at the right-hand side of the table.

- The **Entity** button opens a page with all entities of a type and their metrics.
- The **Data** button opens a page with an overview of statistics on all entities of the type

2.  In the list of Entity Types, locate the **temperatureK** entity type, and click on **Data**.

    The entity type data page opens. Wait for the data to be loaded.
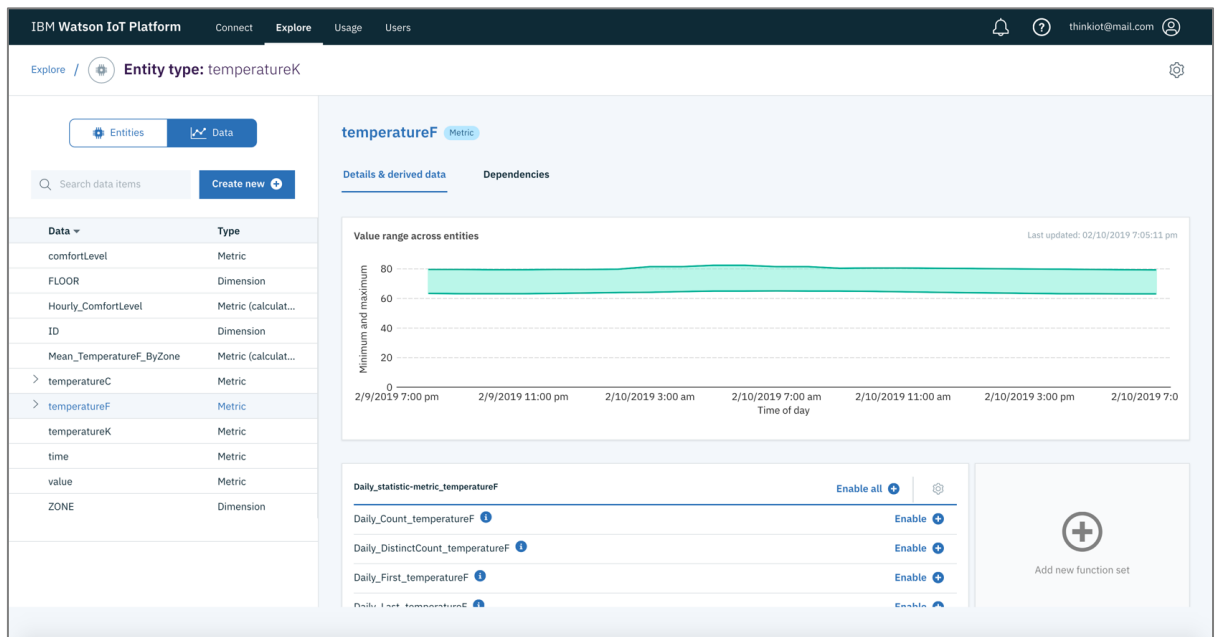


**Note**: The left-hand side navigator provides an overview of the available metrics on the entity type. Note that these are the property names we recognize from the temperatureK_LI interface with Time, Value, Celsius, Fahrenheit and Kelvin state properties.

3.  In the left-hand side **Data** explorer, click on the **temperatureF** property.
    The graph loads the Fahrenheit temperature time-series values with upper and lower value bounds.

    **Note**: In the graph above we see that the upper bound of temperature values are varying and that the max temperatures are slightly higher at office days as compared to weekends. Mouse over the graph to see data values.

7.  Click on the **temperatureC** property.
    The graph updates with Celsius temperature values.

    **Note:** The data values are the time-series data of the temperature values calculated in the temperatureK_LI interface that we explored in section 3.5 Exploring Device State above.

## 4.2 Exploring Entity Data

To view the Entities Types in the Watson IoT Platform Data Lake

1. Choose the **Explore** tab on the Watson IoT Platform banner.
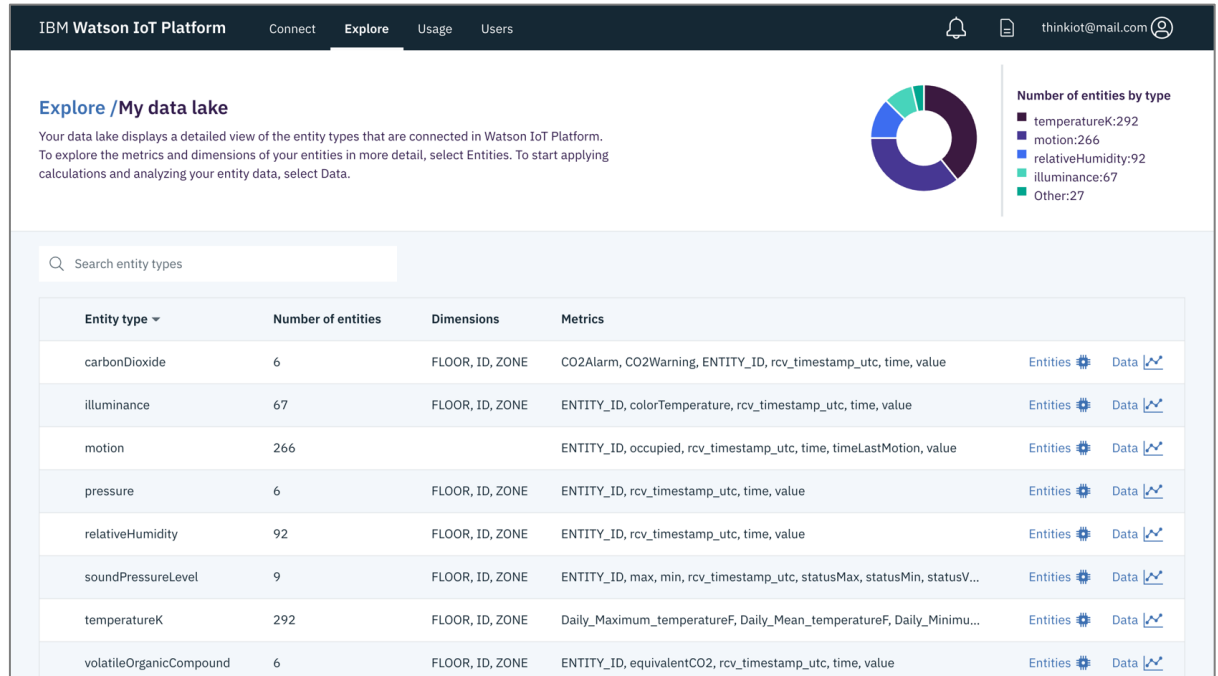


2. In the list of Entity Types, locate the **temperatureK** entity type, and click on the **Entities** button.

   Alternatively, click on the **Entities** tab on the Data page open from the previous section in this lab.

   The Entity page opens showing the list of temperatureK Entities
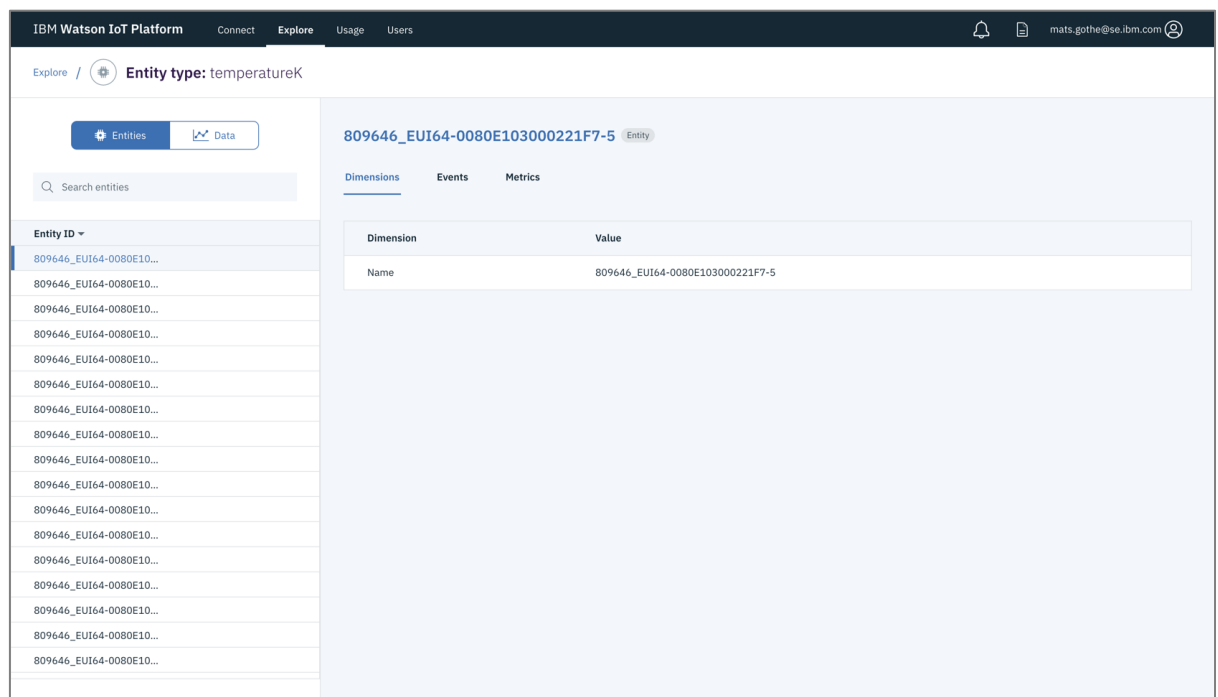
3. Search for entity "809646_EUI64-0080E10300045A93-3", or just "93-3" in the list. This is the temperature sensor in zone 3, floor 27.



**Note**: The **Dimension** tab (see above) shows the metadata for the temperature sensor entity, for example it's **ID**, the **FLOOR** it's located on, and the **ZONE** it's a part of.

4. Select the **Metrics** tab.
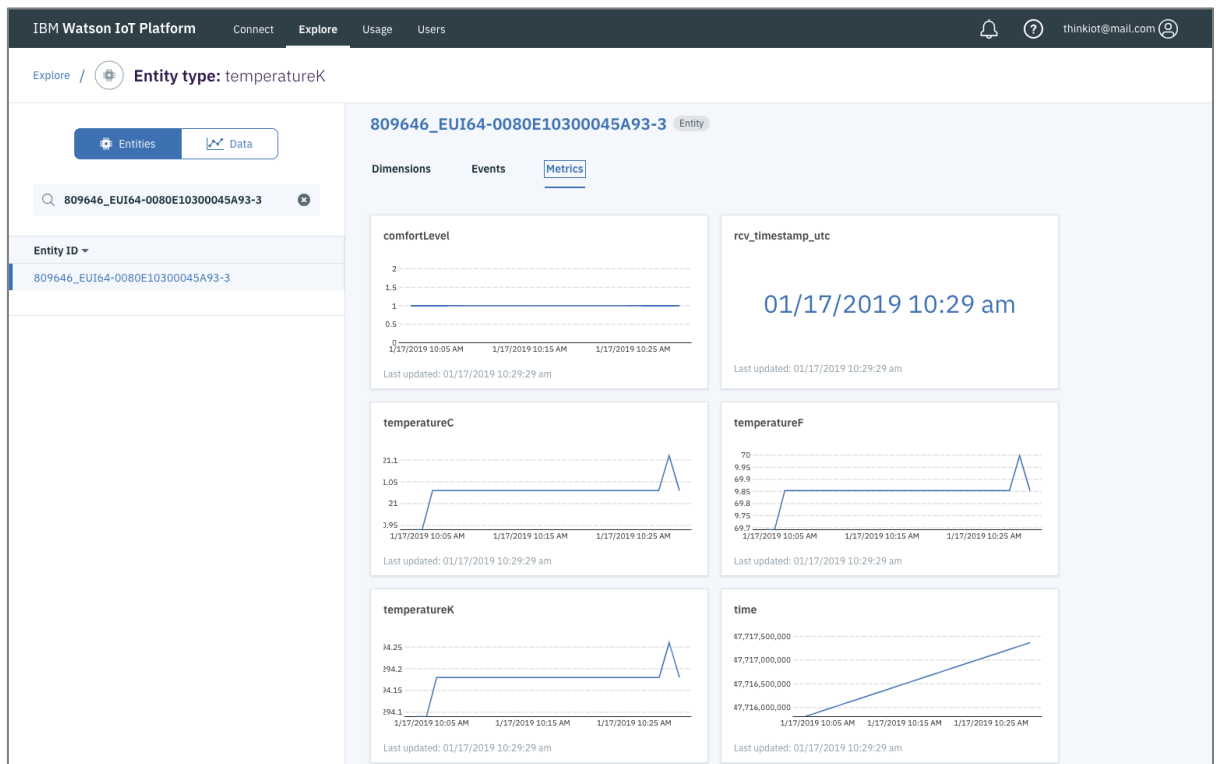


**Note**: Each metric is shown as an individual time-series graph.

You have now completed the exploration of Entity Types and Entries. In the next section we will deepen the exploration and look at Analytics on the Entity Types and Entries.

To learn more about Entity Types and Entries, optionally browse and explore the other types of entities and their data.

# 5 Exploring the Watson IoT Platform Analytics Service

## 5.1 Exploring Derived Metrics

The Watson IoT Platform Analytics Service is an optional add-on component that extends the functionality of Watson IoT Platform Connection Service to include analytics features on entities. Using these capabilities, Line-of-business users can use Watson IoT Platform to interact with their IoT data and derive essential performance indicators.

Watson IoT Platform Analytics delivers a range of functions that you can use to calculate your entity data and derive insights. Functions are stored in a catalog, where you can browse the full range of calculations available. When you are applying calculations to your entity data, you can configure the functions to combine both metrics and dimensions. You can also stage calculations using the output of one function as input to the next computation stage. In essence, the complexity of your calculations is controlled by you. The output of a function is saved in the data lake as a derived metric. Secondary calculations can be applied to the results of the first, so that you can conduct deeper analyses.

To streamline your data analysis, function sets can be created and configured. Function sets run multiple functions simultaneously and provide a broader set of data as their output. By applying calculations to your data, you can view a summary of specific activity. From that summary, you can define KPIs and aggregate the data as you want.

To view computed metrics on an entity

1.  Repeat the steps from previous section to open the **temperatureK** entity data page

    - Choose **Browse** from the navigation bar

    - Click the **Data** button on the temperatureK entity type table row
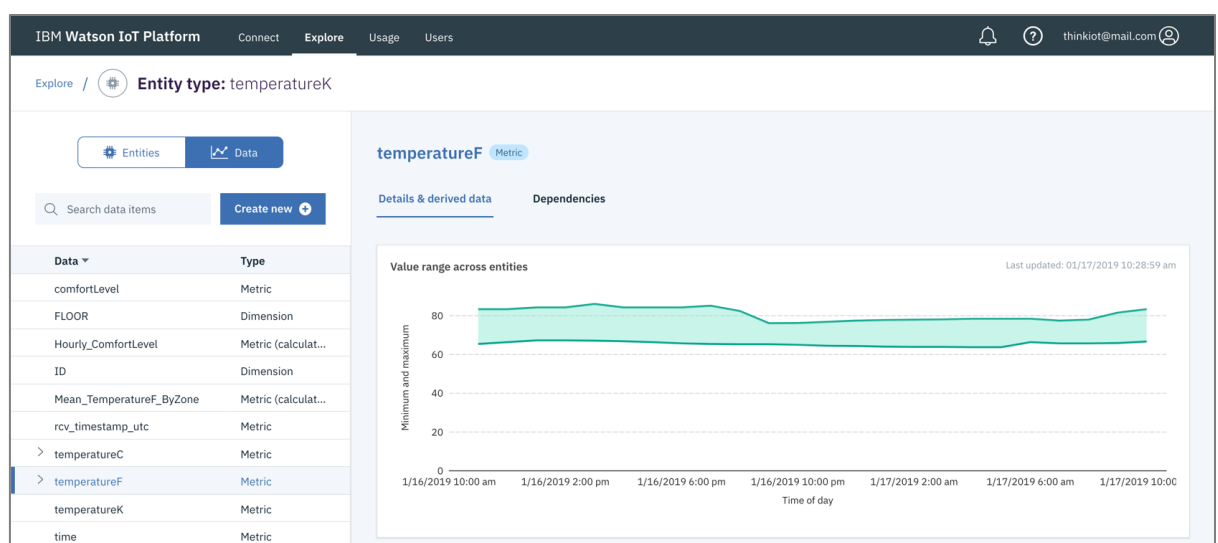
2. In the left-hand **Data** explorer, click on **>** to expand the temperatureF data section. Three derived metrics are shown

- Daily Maximum Fahrenheit temperatures

- Daily Average / Mean Fahrenheit temperatures

- Daily Minimum Fahrenheit temperatures
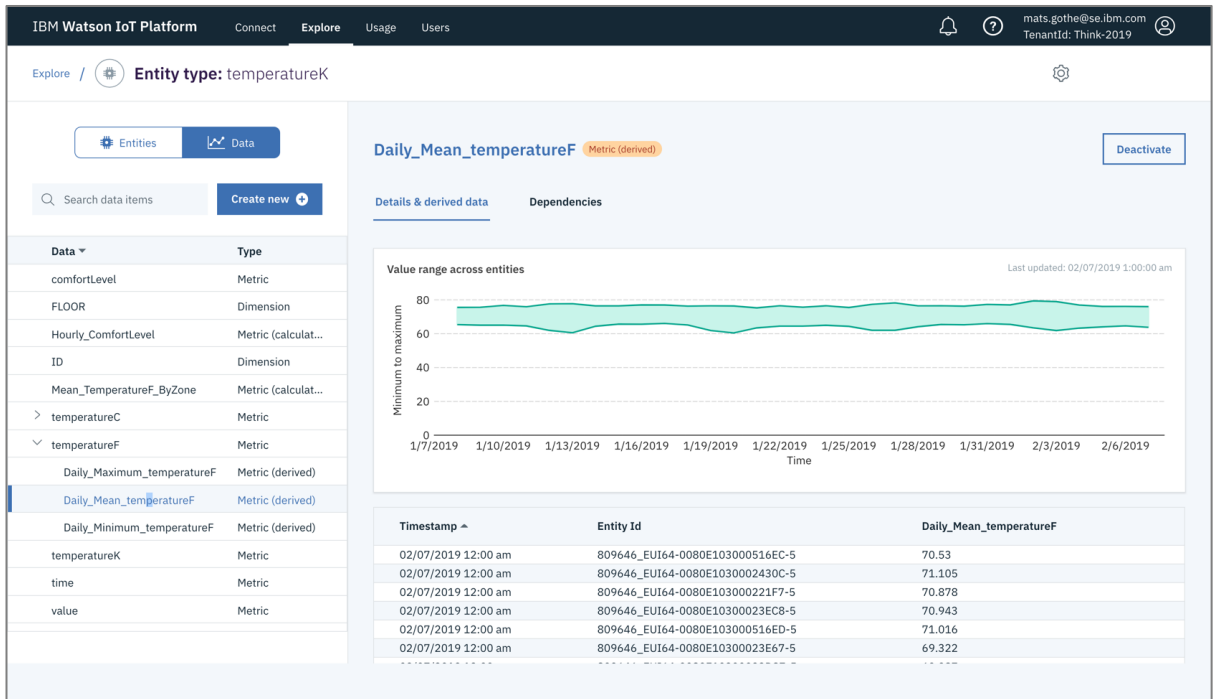


5. Scroll down on the page to view the daily statistical values for the temperature sensor recently delivering new IoT data.
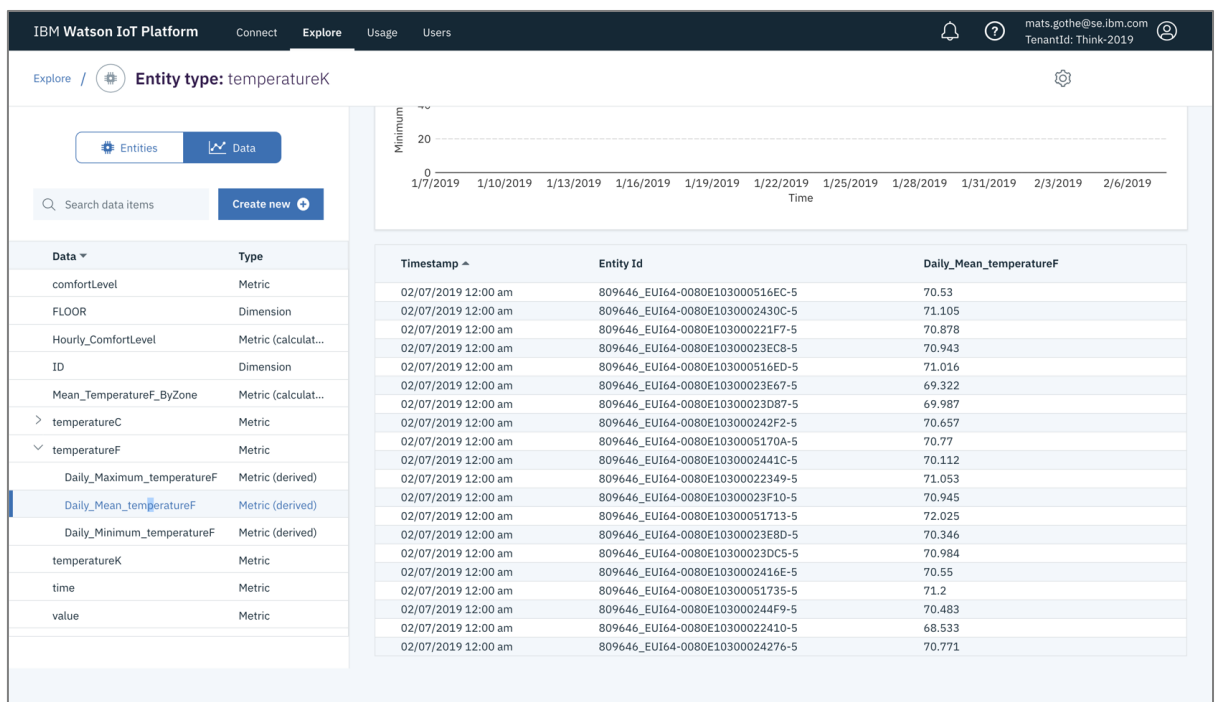
## 5.2  Exploring Analytics on Temperature Comfort Levels

The temperatureK devices are providing compliance to comfort levels as part of the temperatureK_LI. This comfortLevel property is computed by the logical interface using the following expression:

```
($event.value > 293.15) and ($event.value < 297.6)? 1.0 : 0.0
```

The logic of this expression is that the property will be set to the value 1.0 if the temperature is in rage 68-76 degrees Fahrenheit. (Note that the temperatures in the expression are given in Kelvin degrees). If the temperature is outside of this range the comfortLevel is set to 0.0. The value 1.0 is given as a percentage (%) of compliance to the comfort level. While this value makes little sense as a single value of a single sensor it becomes valuable raw data for metric aggregation and statistics. For example, as an average over a time period, computing a statement of comfort level over a day. Or as an average over sensors, computing a statement of compliance across sensors in a zone or a floor.

To view the compliance of the temperature comfort level

1. Select the **Hourly_ComfortLevel** metric from the **Data** explorer on the **temperatureK** entity type.

2. View the graph on the daily variance of comfort levels
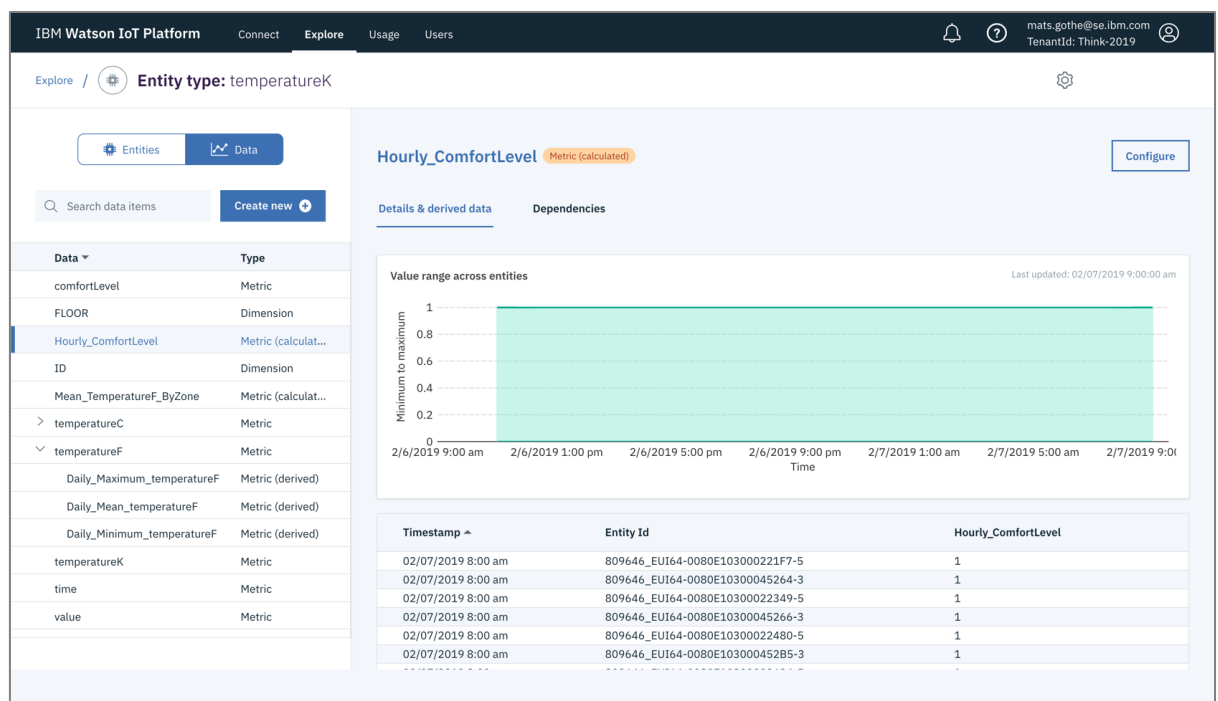
3. Scroll down the page and view the comfort levels across the various sensors. View the computed comfort Level for the last hour.
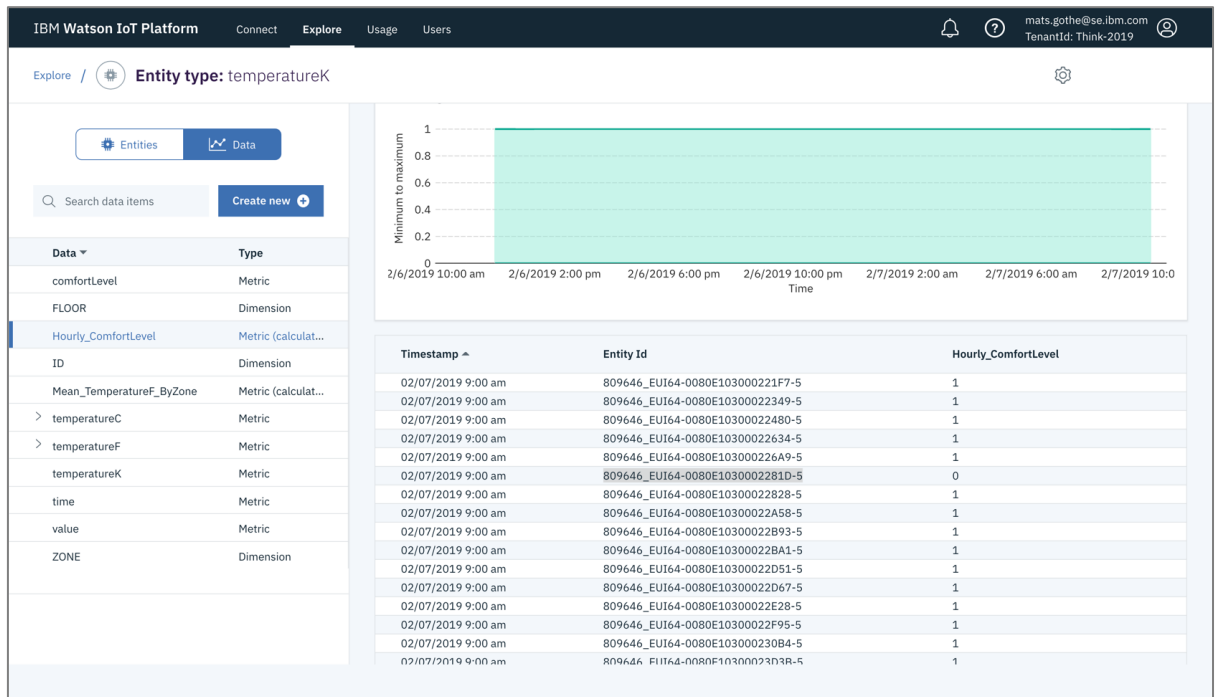


**Note**: On the day of capturing these notes, uncomfortable temperatures were detected by the 809646_EUI64-0080E1030002281D-5 sensor.

## 5.3 Exploring CO₂ Alerts and Analytics on Worker Safety

The Watson IoT Platform Analytics Service can create and configure alerts to produce events. The events are saved in the data lake and can be viewed in the Watson IoT Platform Analytics Such. Events can be pushed as messages to IBM Event Streams for IBM Cloud service running in the Watson IoT Platform tenant. Alerts can be configured to trigger when your data exceeds specific thresholds.

To configure alerts in Watson IoT Platform Analytics, you must author custom Python expressions. An expression is a combination of values, variables, operators, and calls to functions. Expressions can contain operations, such as addition or subtraction.

**Note**: Watson IoT Platform Analytics supports Pandas libraries for building expressions.

To view warnings and alerts on CO₂ levels

1. Open the carbonDioxide entity data page

   a. Choose **Browse** from the IoT Platform navigation bar

   b. Click **Data** on the **carbonDioxide** entity type table row

   c. Click on the **value** property

The carbonDioxide entity data page is loaded showing the $CO_2$ levels.
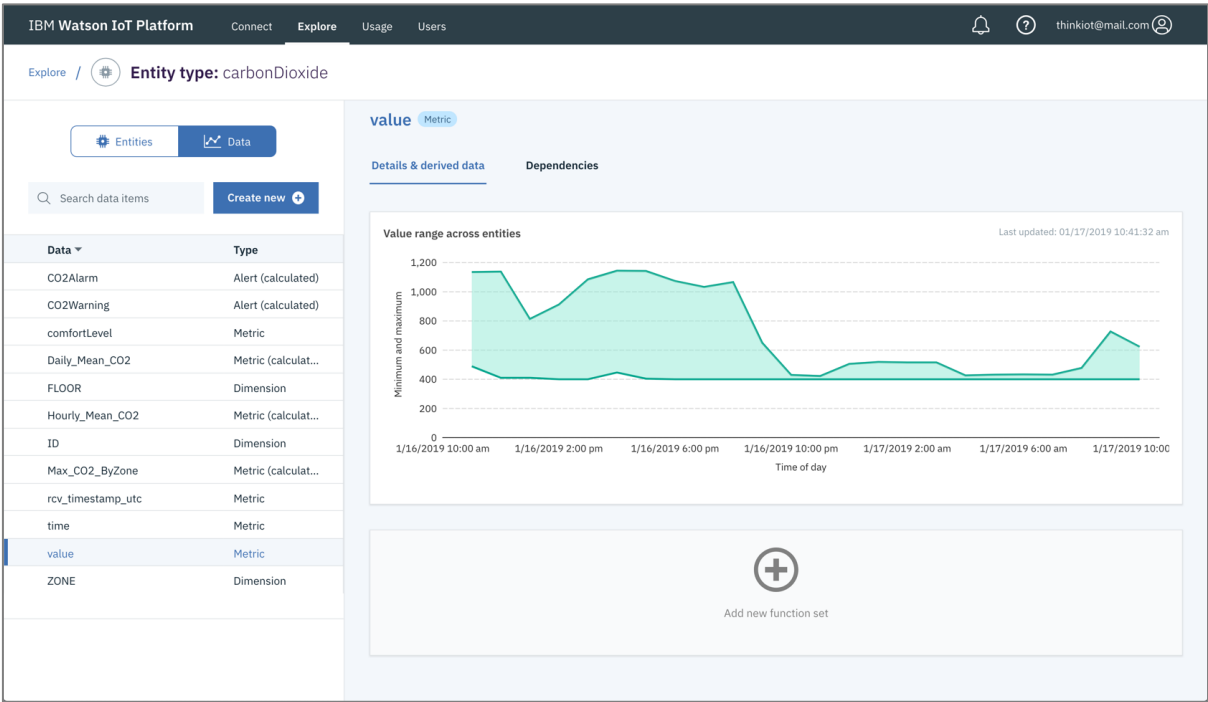


**Note**: On the day of capturing these notes, high $CO_2$ levels was detected at office hours and less at non-office hours. Levels were right and above the comfort levels of 1000 PPM.

2. In the **Data** browse, click on the alert **CO2Warning**.
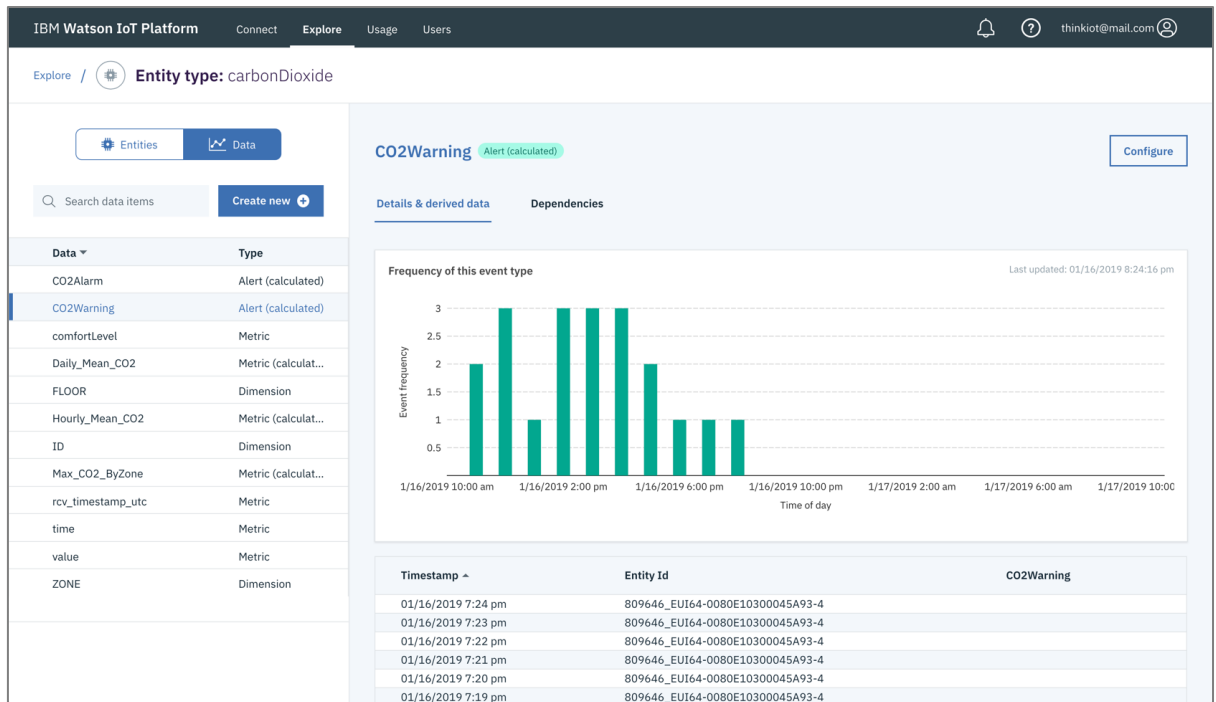


**Note**: Comparing the time of alarms and warning we see that these are reached early in the from sensors 809646_EUI64-0080E10300045A93-4. This is sensors in zone 3 meeting room indicating presence of multiple people in the room.

To view the configuration of warning and alarm rules on the $CO_2$ levels.

1. Select the **CO2Alarm** or **CO2Warning** alerts in the data table.

2. Click on the **Configure** button to the left above the graph

3. The alert definition is shown.

**Note**: The alert expression for the CO2Alarm is "${value}>1000". Hence, any sensor reading of the $CO_2$ level that has a value above 1000 PPM will cause an alarm to be raised. Level of $CO_2$ above 1000 PPM causes headaches and drowsiness and impacts worker safety.

4. Click **Cancel** to close the alert function dialog.

To gain deeper insights into the hourly and daily $CO_2$ levels

1. In the **Data** explorer, click on the **Hourly_Mean_CO2** metric and view the max – min level values. For details, view the hourly mean $CO_2$ levels in the table below.

2. In the **Data** explorer, click on the **Daily_Mean_CO2** metric and view the max – min level values. For details, view the daily mean $CO_2$ levels in the table below

3. Look for sensors that are showing levels impacting worker safety. Are the levels consistent, or peaking at any special day or hour?
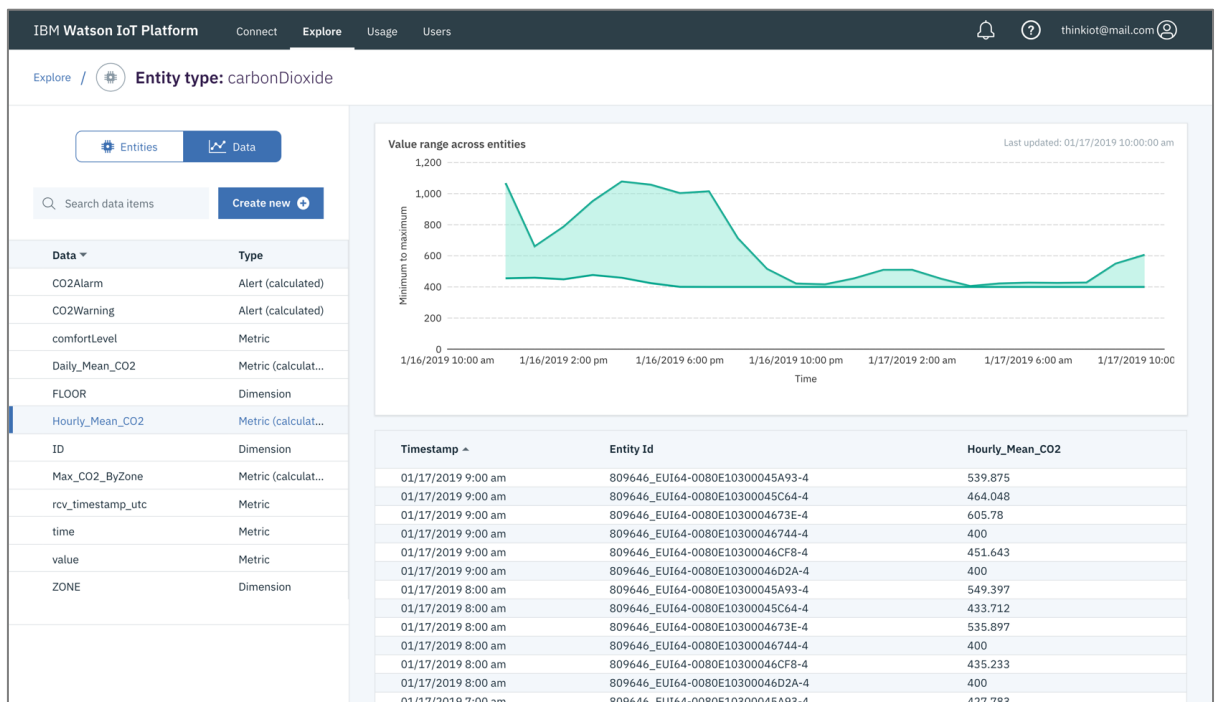
To gain deeper insights into the $CO_2$ levels and impact on Zones.

5. Click on the **Entities** tab to switch to the entities.

6. Type or paste the carbonDioxide entity id into the search box.



**Note**: The Dimension table shows that the "809646_EUI64-0080E10300045A93-4" carbonDioxide sensor is located on floor 27 in Zone 3.

To further deeper insights into the $CO_2$ levels in Zone 17.

7. Click on the **Metrics** tab to switch to the time series data for the entity.

The metrics data and graphs are loaded.

We can now conclude that this is a meeting room with generally bad air quality throughout the day. This may cause an action to be triggered in creating a Work Order to the facility manager to check up the room ventilation.

If your data reaches a range that activates an alert, the alert is published to an Event Streams topic. Watson IoT Platform Analytics provides an Event Streams topic called analytics-alerts-<tenantId>, where <tenantId> is your own tenant ID. When an alert is triggered, Watson IoT Platform Analytics publishes a message to the analytics-alerts-<tenantId> topic. This lab does not cover the developer experience to integrate with Event Streams and handle events and actions.

## 5.4 Exploring Analytics on Occupancy and Utilization

The Watson IoT Platform Analytics Service can perform advanced data science analytics on entity data using analytics functions out-of-the-box in the function catalog, or add custom functions extending the catalog. To extend the functions in Watson IoT Platform Analytics, you must author custom Python code. In this lab we will only use predefined functions from the function catalog.

To exemplify more advanced analytics functions we will explore the utilization of zones at the 27th floor in the IoT Center in Munich.
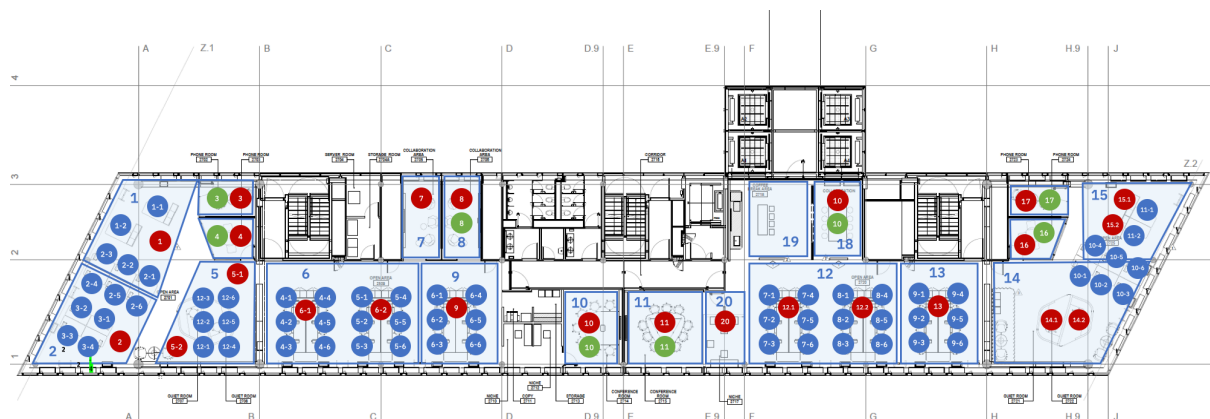


Most all zones in the IoT Center in Munich has been equipped with motion sensors, as indicated by blue and red circles in the floor plan below. The motion and motion+ sensors send periodic events to the IoT platform with three motion properties; value, time and timeLastMotion. The *value* property is the amplitude or size of motion detected near the sensor. The *time* is a time-stamp expressed in milliseconds. and the *timeLastMotion* is the time-stamp of the last previous event when motion was detected.

Using the time and timeLastMotion, the IoT platform can compute occupancy in the workspace. The assumption made is that a workspace is occupied if motion is detected within a 1 ½ minute interval. Hence, "isOccupied" is a state property computed by motion_LI logical interface using the expression below. The time since last motion detected is less than 90.000 milliseconds. The property is set to 1.0 of the space is occupied, or 0.0 of the space is unoccupied. Similar to the comfort level this property can be used for time-series and aggregation metrics.

```
($event.time - $event.timeLastMotion)<90000 ? 1.0 : 0.0
```

Also, a lastOccupied property is computed for the time interval in minutes since motion was last detected. This property is caped to a day, i.e. no more than 1440 minutes, equal to a day of unoccupancy.

```
($event.time - $event.timeLastMotion) / 60000 > 1440 ? 1440 :
$round(($event.time - $event.timeLastMotion) / 60000)
```

Optionally, return to the Watson IoT Platform Service to view the motion_LI logical interface

1. Return to the Watson IoT Platform Service
2. Select the **Devices** section, the **Data Type** tab and the **motion** data type
3. Select the **Interface** tab and click **Next** to view the **State Model** page
4. Click in the eye-icon to view the property expression for **isOccupied** and **lastOccupied**
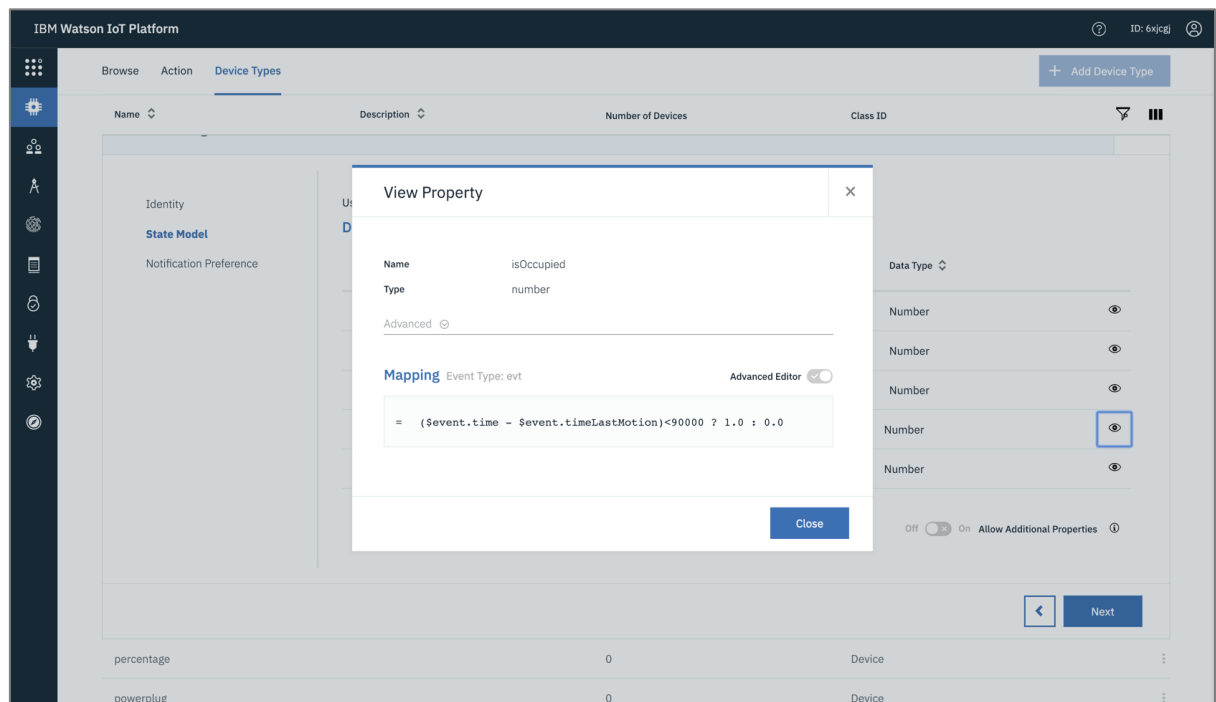


**Note**: there are two editors for property expression; a simple expression building and an advanced code editor. The **isOccupied** property above is using the advanced editor and the JSONata expression language to encode the function.

On the function above the $event object is holding the data payload from the event. The = ? : expression is the JSONata syntax for an if-statement.

To learn more about JSONata, visit the http://jsonata.org home page.

To view motion entity data

1. Open the **motion** entity data page

2. Select the **isOccupied** metric
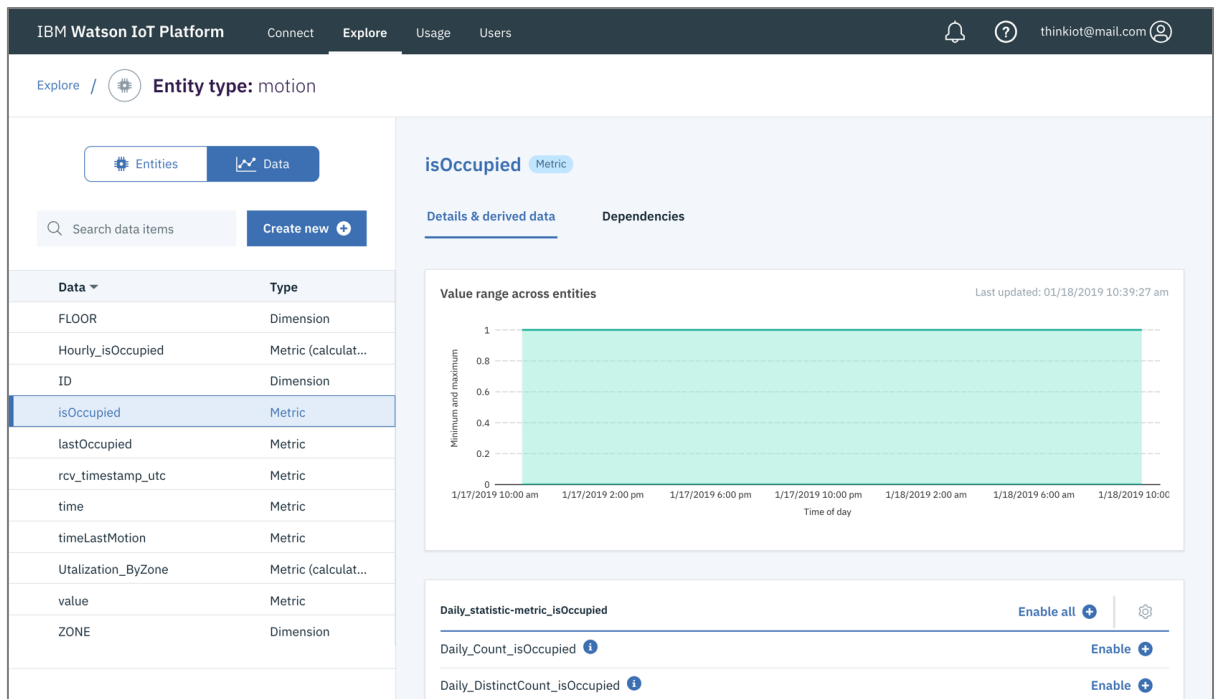


**Note**: The graph shows the daily occupancy across all motion sensors. As previously discussed, the sensors send a numeric 0.0 or 1.0 value, and the graph will show values between these min and max numbers. This may not be that interesting, but analytics on groups of sensors will be more descriptive of the utilization. We will explore that later in this section.

We will now explore occupancy by zone in the west wing of floor 27.
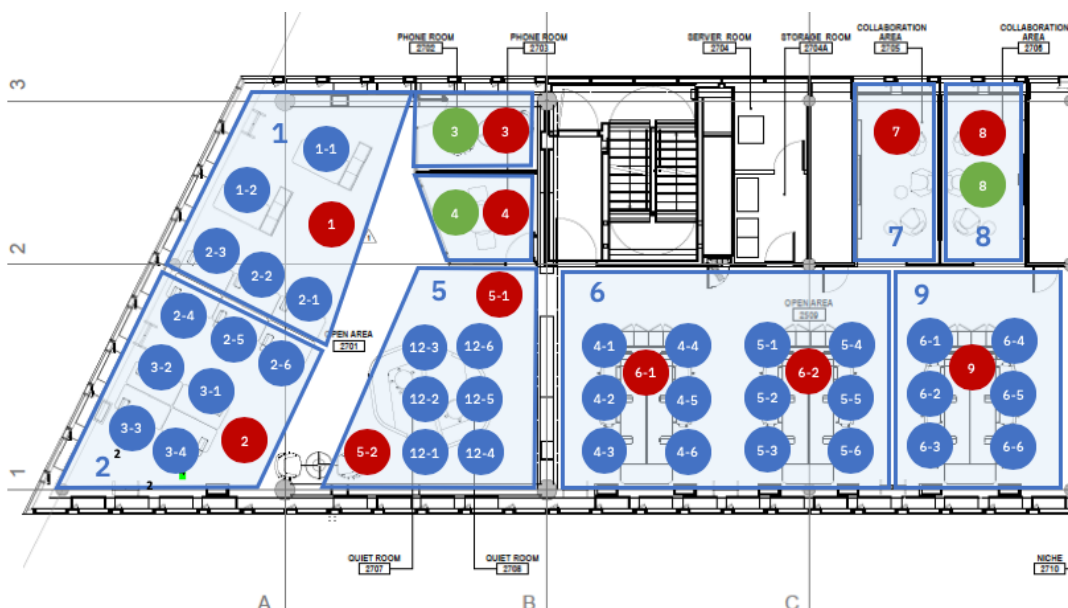
To view occupancy by individual sensor

1. Click on **Entities** to switch to the entity page of motion sensors

2. Use the search field to locate the motion sensors in the west wing of floor 27.

   - Motion sensor in zone 3: 809646_EUI64-0080E10300045**266-4**

   - Motion sensor in zone 4: 809646_EUI64-0080E10300045**264-4**

3. Select the found entity in **Entity ID** list, and select the **Metrics** graph
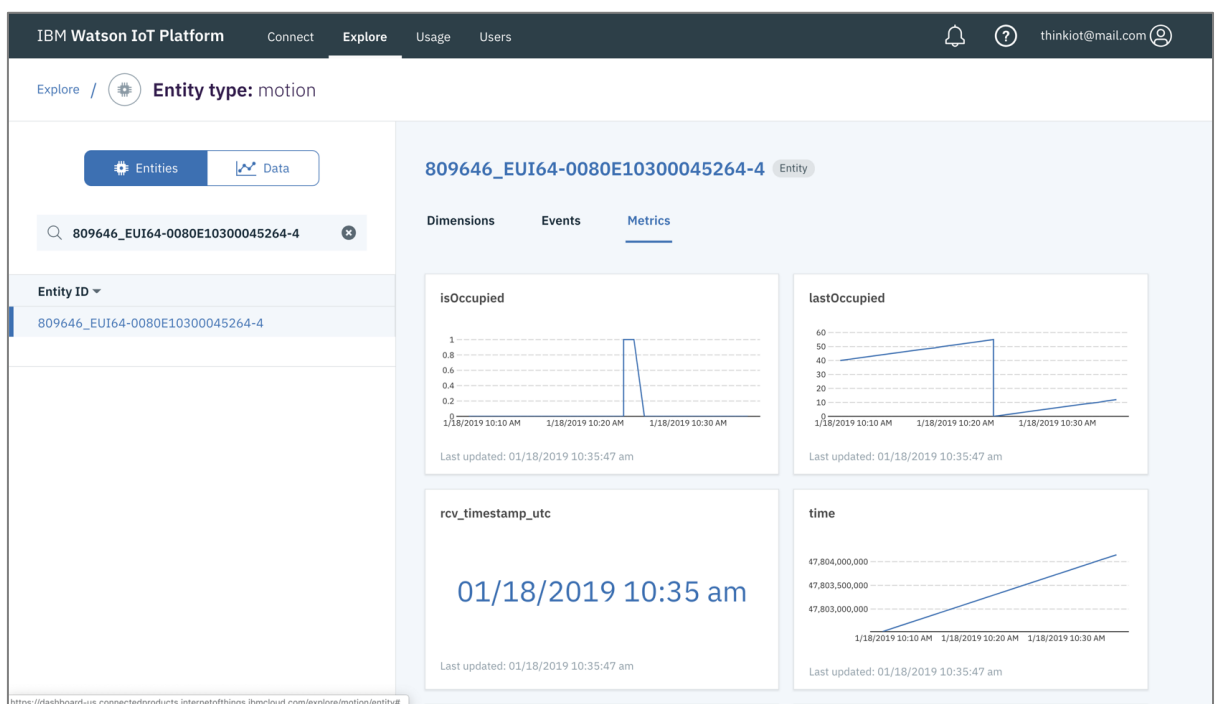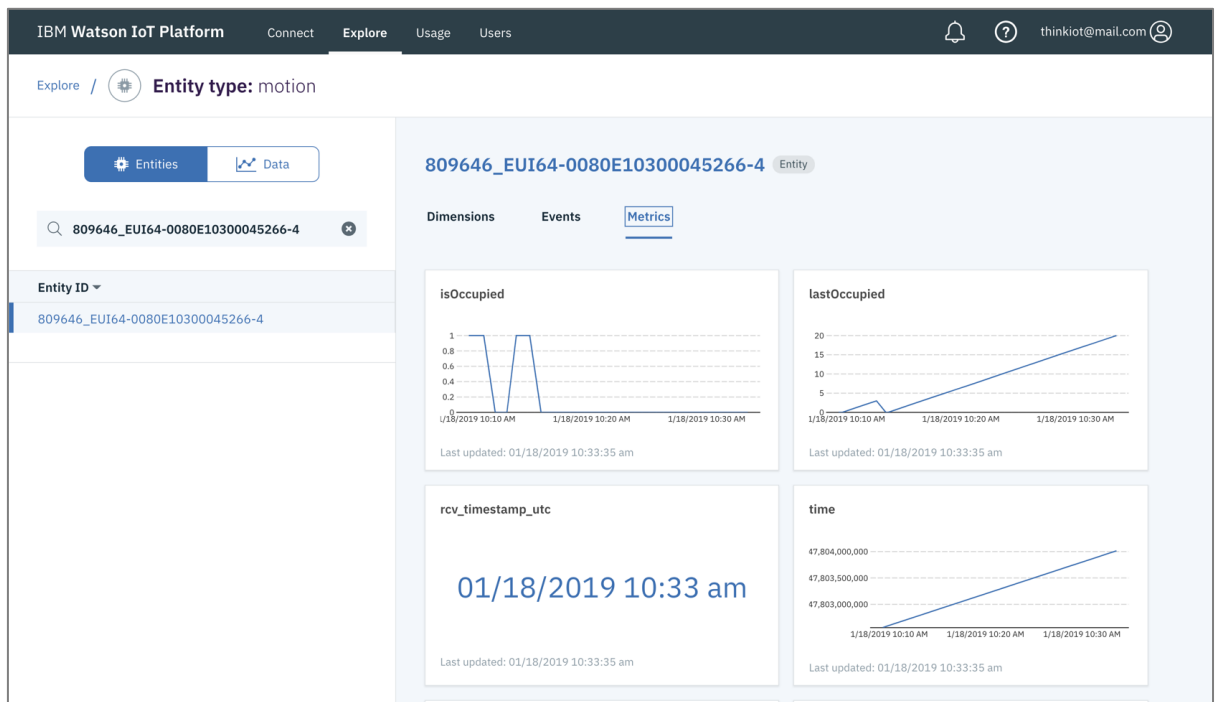




**Note**: The isOccupied graph shows the occupancy of the workspace.

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Using the isOccupied metric, the Watson IoT platform Analytics Service can be used to compute utilization of workspace. The assumption is made that the average of occupancy is a utilization percentage 0-100% of the zone over a given time window. The utilization applies to both aggregates over time-series, sensor aggregates in a zone, or sensor aggregates over multiple zones. The utilization will in itself be an hourly, daily time series with Max, Min and Average metrics.
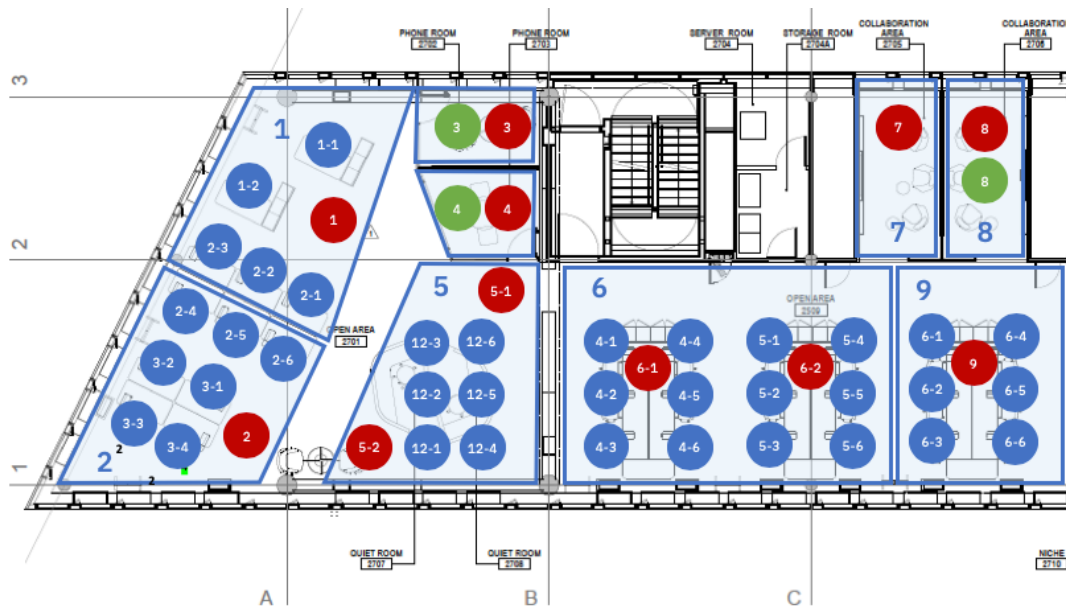


To view utilization by workstation

4. Use the search field to locate the motion sensors in the west wing of floor 27. (see index of devices on next page)

5. Use the search field to locate the motion sensors in the East wing of floor 27.

   - Motion sensor in zone 1: 809646_EUI64-0080E10300045607-4

   - Motion sensor in zone 2: 809646_EUI64-0080E103000451D3-4

   - Motion sensor in zone 3: 809646_EUI64-0080E10300045266-4

   - Motion sensor in zone 4: 809646_EUI64-0080E10300045264-4

   - Motion sensor in zone 5: 809646_EUI64-0080E103000451A3-4

   - Motion sensor in zone 6: 809646_EUI64-0080E103000451A5-4

   - Motion sensor in zone 7: 809646_EUI64-0080E103000452B7-4

   - Motion sensor in zone 8: 809646_EUI64-0080E1030004507E-4

   - Motion sensor in zone 9: 809646_EUI64-0080E1030004542F-4

   **Note**: Use the device table in Appendix A to list and find devices by zone. Alternatively, browse the devices in the Watson IoT Platform and filter by the **device type** and **descriptive location** columns.

6. View the **Hourly_isOccupied** utilization metrics



**Note**: The hourly mean value of isOccupied is presented for each sensor. Workspaces fully used during the hour will average to 1.0, workspaces with no occupancy will average to 0.0, and workspaces with partial occupancy will compute as a percentage of utilization, for example 0.25 as 25% utilization.

7. View the **Utalization_ByZone** utilization metrics



**Note**: The utilization by zone function is computing an aggregated mean value from all sensors with a common Dimension, hence all sensors in a Zone.

To view the function definition of the **Utalization_ByZone** metrics

8. Select the **Utalization_ByZone** utilization metrics



9. On the metric side card, click on the **Configure** button



**Note**: On this page we select the metric used as the source for the Mean function.

10. Click on **Next**



**Note**: On this page we name the new metric to **Utalization_ByZone**

11. Click on **Manage** to view the granularity definition for this function

12. Click on the **pen** icon to edit the ByZone granularity.



**Note**: The **Utalization_ByZone** metric defined to aggregate the data from all entities with a common ZONE.

Other aggregated metrics are component for $CO^2$ and Temperature.

13. Select the carbonDioxide entity type and view the Max_CO2_ByZone.

Explore / Entity type: carbonDioxide

Entities | Data

Search data items | Create new

The following error occurred while retrieving your data. Error loading data item graph.

| Data | Type |
|---|---|
| CO2Alarm | Alert (calculated) |
| CO2Warning | Alert (calculated) |
| comfortLevel | Metric |
| Daily_Mean_CO2 | Metric (calculat... |
| FLOOR | Dimension |
| Hourly_Mean_CO2 | Metric (calculat... |
| ID | Dimension |
| Max_CO2_ByZone | Metric (calculat... |
| time | Metric |
| value | Metric |
| ZONE | Dimension |

| Timestamp | Entity Id | ZONE | Max_CO2_ByZone |
|---|---|---|---|
| 02/09/2019 6:00 am | | 4 | 430 |
| 02/09/2019 7:00 am | | 4 | 429 |
| 02/09/2019 8:00 am | | 4 | 431 |
| 02/09/2019 9:00 am | | 4 | 431 |
| 02/09/2019 6:00 am | | 8 | 400 |
| 02/09/2019 7:00 am | | 8 | 400 |
| 02/09/2019 8:00 am | | 8 | 400 |
| 02/09/2019 9:00 am | | 8 | 400 |
| 02/09/2019 6:00 am | | 16 | 412 |
| 02/09/2019 7:00 am | | 16 | 412 |
| 02/09/2019 8:00 am | | 16 | 412 |
| 02/09/2019 9:00 am | | 16 | 400 |
| 02/09/2019 6:00 am | | 17 | 542 |
| 02/09/2019 7:00 am | | 17 | 540 |
| 02/09/2019 8:00 am | | 17 | 540 |
| 02/09/2019 9:00 am | | 17 | 539 |
| 02/09/2019 6:00 am | | 18 | 401 |
| 02/09/2019 7:00 am | | 18 | 403 |
| 02/09/2019 8:00 am | | 18 | 400 |
| 02/09/2019 9:00 am | | 18 | 400 |

14. Select the temperatureK entity type and view the Mean_TemperatureF_ByZone.

Explore / Entity type: temperatureK

Entities | Data

Search data items | Create new

No recent data is available 2/8/2019 10:00 am - 2/9/2019 10:00 am

| Data | Type |
|---|---|
| comfortLevel | Metric |
| FLOOR | Dimension |
| Hourly_ComfortLevel | Metric (calculat... |
| ID | Dimension |
| Mean_TemperatureF_ByZone | Metric (calculat... |
| temperatureC | Metric |
| temperatureF | Metric |
| temperatureK | Metric |
| time | Metric |
| value | Metric |
| ZONE | Dimension |

| Timestamp | Entity Id | ZONE | Mean_TemperatureF_ByZone |
|---|---|---|---|
| 01/15/2019 4:00 pm | | 1 | 74.009 |
| 01/15/2019 4:00 pm | | 1 | 74.602 |
| 01/15/2019 4:00 pm | | 2 | 78.366 |
| 01/15/2019 4:00 pm | | 2 | 77.607 |
| 01/15/2019 4:00 pm | | 3 | 73.894 |
| 01/15/2019 4:00 pm | | 3 | 74.097 |
| 01/15/2019 4:00 pm | | 4 | 74.962 |
| 01/15/2019 4:00 pm | | 4 | 74.613 |
| 01/15/2019 4:00 pm | | 5 | 74.951 |
| 01/15/2019 4:00 pm | | 5 | 74.707 |
| 01/15/2019 4:00 pm | | 6 | 73.824 |
| 01/15/2019 4:00 pm | | 6 | 73.992 |
| 01/15/2019 4:00 pm | | 11 | 71.2 |
| 01/15/2019 4:00 pm | | 12 | 73.507 |
| 01/15/2019 4:00 pm | | 13 | 72.043 |
| 01/15/2019 4:00 pm | | 14 | 71.156 |
| 01/15/2019 4:00 pm | | 15 | 72.691 |
| 01/15/2019 4:00 pm | | 16 | 71.096 |
| 01/15/2019 4:00 pm | | 17 | 70.427 |
| 01/15/2019 4:00 pm | | 18 | 71.588 |
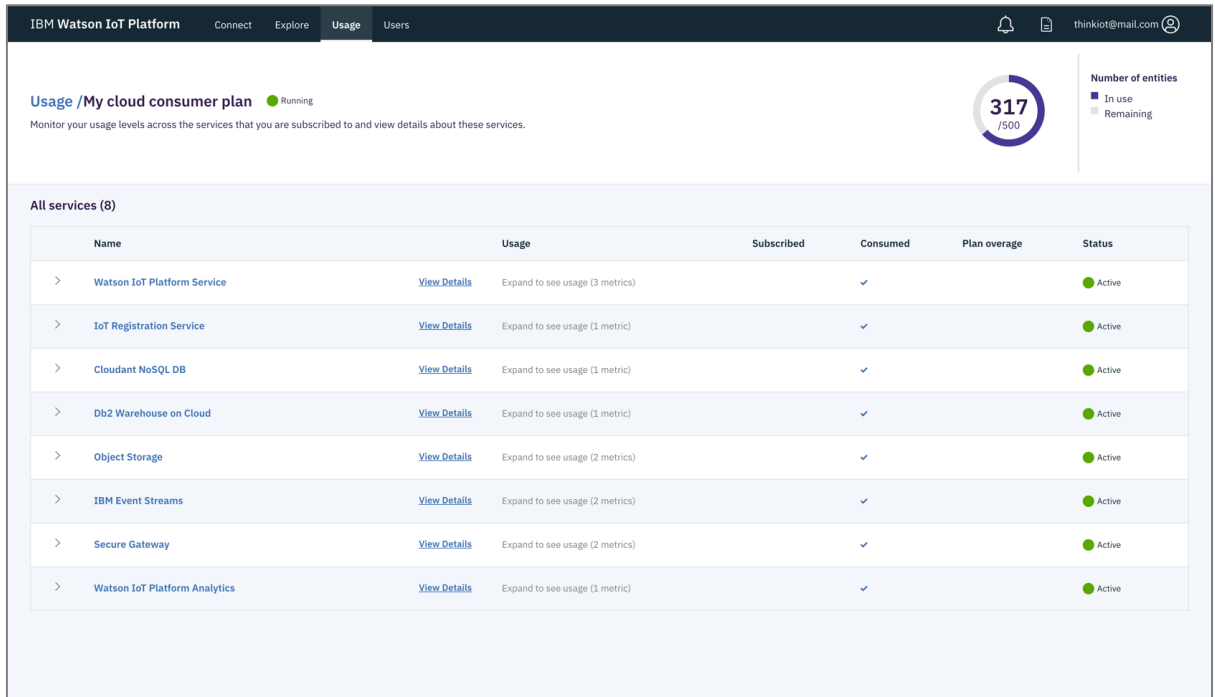
We have now completed the exploration of the Watson IoT Platform Analytics Service.
In the following section we will look at platform administration and user management.

# 6  Exploring the Watson IoT Platform Administration

In this last section of the lab we will look at platform administration and user management.

To view the configured services, their health status and connection credentials

1. Select the **Usage** tab on the Watson IoT Platform banner.



**Note**: View the status for the individual service preconfigured for this IoT platform tenant.

2. Click on **View Details** on Db2 Warehouse on the Cloud row in the list of services.

**Note**: The dialog shows the credential for the Db2 web administration tool and other properties on the data service.

To view the users of the IoT platform

1.  Select the **Users** tab on the Watson IoT Platform banner.
2.  The User page opens



**Note**: We advise to not make changes on the user list for this lab.

You have now completed overview of administration capabilities in the Watson IoT Platform. We will now proceed to explore the Watson IoT Platform and the connected devices in the IoT Center in Munich

# 7  Conclusions from this Watson IoT Platform lab

You have now completed this hands-on lab on Getting started with IoT Edge Gateways.

During this lab you have:

- Deepened your understanding of the Watson IoT Platform Service and how Device Types and Device are declared, registered and connected to send events to the IoT platform. You have also explored the definition of Interfaces and Device State transformations.

- Deepened your understanding of the Watson IoT Platform Connection Service and how Entity Types, Entities and Metrics are stored in the IoT platform data lake.

- Deepened your understanding of the Watson IoT Platform Analytics Service and how to create Computed Metrics using function in the Function Catalog.

We hope that you have found this lab informative, educational, and fun.

## 7.1  Further reading

To learn more about the Watson IoT Platform

- Watson Internet of Things
  https://www.ibm.com/internet-of-things

- Watson IoT Platform on ibm.com
  https://www.ibm.com/internet-of-things/spotlight/watson-iot-platform

- Watson IoT Platform blog
  https://developer.ibm.com/iotplatform/blog

- Watson IoT Platform on IBM Developer Works
  https://www.ibm.com/developerworks/learn/iot/

To further explore, sign up for a trial account on IBM Cloud, create the IBM Watson IoT Platform service, and start connecting your IoT devices

## 7.2  We Value Your Feedback!

- Don't forget to submit your Think 2019 session and speaker feedback! Your feedback is very important to us – we use it to continually improve the conference.

- Access the Think 2019 agenda tool to quickly submit your surveys from your smartphone, laptop or conference kiosk.

# 8  APPENDIX A

## 8.1  Device types and identities

Registered devices at 27th floor in the Munic IoT Center.

In the floor plan below
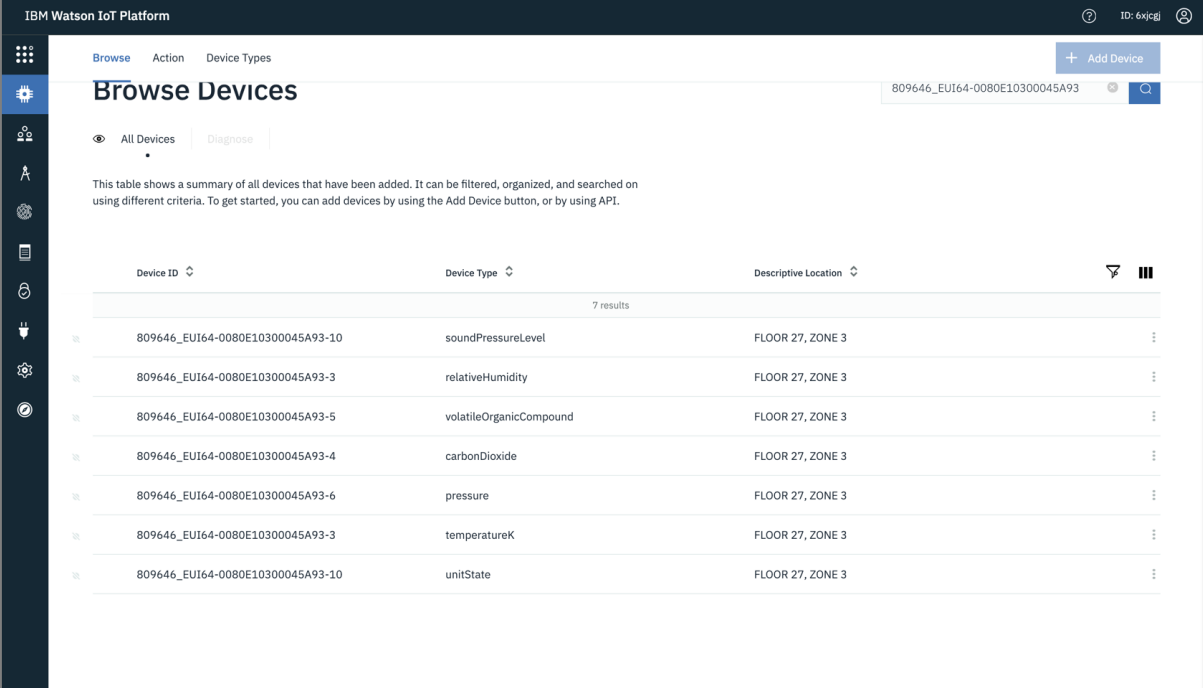
- **Zones** are indicated with numbered blue areas
- **Comfort** devices, red numbered circles
- **Motion plus** devices, green numbered circles
- **Motion** devices, blue numbered circles



As an example, Zone 1 has one Comfort device and Motion devices 1-1 , 1-2 and 2-1, 2-2, 2-3. For registered sensor id's reference the device table below.

## 8.2  Registered Sensors

In the table below, sensors are registered with an extension indicating their sensor type. For example, the device in Zone 3 with ID 3 is the Comfort device 809646_EUI64-0080E10300045A93 is registering six sensors; with extensions -3, -4, -5, -6 and -10



Another example is the Motion+ device EUI64-0080E10300045266, also in Zone 3, registering 5 sensors with extensions -3, -4, -5, -10

All sensors on floor 27 are listed in the table below by Zone, ID, Type and Device ID. The sensor types registred are given in the columns to the right using the following short name.

**T**     temperatureK
**M**     motion
**CO2**   carbonDioxide
**P**     pressure
**SP**    soundPressureLevel
**RM**    relativeHumidity
**VOC**   volatileOrganicCompound
**I**     illumination

For example, Comfort device EUI64-0080E10300045A93 in Zone 3 registers T, CO2, P, SP, RH, VOC sensors with the given extensions to the device name.

Use the table below to identify the devices and sensors you explore in your analytics.

| ZONE | ID | YANZI | DEVICE | T | M | CO2 | P | SP | RH | VOC | I |
|------|------|-------------|----------------------|----|----|-----|----|-----|----|-----|----|
| 1 | 1 | Motion Plus | EUI64-0080E10300045607 | -3 | -4 | | | -10 | -3 | | -5 |
| 1 | 1-1 | Motion | EUI64-0080E1030005113E | -5 | -4 | | | | | | |
| 1 | 1-2 | Motion | EUI64-0080E10300052476 | -5 | -4 | | | | | | |
| 1 | 2-1 | Motion | EUI64-0080E10300051D53 | -5 | -4 | | | | | | |
| 1 | 2-2 | Motion | EUI64-0080E10300052752 | -5 | -4 | | | | | | |
| 1 | 2-3 | Motion | EUI64-0080E103000516EC | -5 | -4 | | | | | | |
| 2 | 2 | Motion Plus | EUI64-0080E103000451D3 | -3 | -4 | | | -10 | -3 | | -5 |
| 2 | 2-4 | Motion | EUI64-0080E10300052215 | -5 | -4 | | | | | | |
| 2 | 2-5 | Motion | EUI64-0080E103000526DD | -5 | -4 | | | | | | |
| 2 | 2-6 | Motion | EUI64-0080E1030002416E | -5 | -4 | | | | | | |
| 2 | 3-1 | Motion | EUI64-0080E10300051973 | -5 | -4 | | | | | | |
| 2 | 3-2 | Motion | EUI64-0080E10300051B4B | -5 | -4 | | | | | | |
| 2 | 3-3 | Motion | EUI64-0080E10300022634 | -5 | -4 | | | | | | |
| 2 | 3-4 | Motion | EUI64-0080E10300024510 | -5 | -4 | | | | | | |
| 3 | 3 | Comfort | EUI64-0080E10300045A93 | -3 | | -4 | -6 | -10 | -3 | -5 | |
| 3 | 3 | Motion Plus | EUI64-0080E10300045266 | -3 | -4 | | | -10 | -3 | | -5 |
| 4 | 4 | Comfort | EUI64-0080E10300045C64 | -3 | | -4 | -6 | -10 | -3 | -5 | |
| 4 | 4 | Motion Plus | EUI64-0080E10300045264 | -3 | -4 | | | -10 | -3 | | -5 |
| 5 | 12-1 | Motion | EUI64-0080E103000511B8 | -5 | -4 | | | | | | |
| 5 | 12-2 | Motion | EUI64-0080E10300051A82 | -5 | -4 | | | | | | |
| 5 | 12-3 | Motion | EUI64-0080E1030005241D | -5 | -4 | | | | | | |
| 5 | 12-4 | Motion | EUI64-0080E103000510F6 | -5 | -4 | | | | | | |
| 5 | 12-5 | Motion | EUI64-0080E103000523F9 | -5 | -4 | | | | | | |
| 5 | 12-6 | Motion | EUI64-0080E10300051C50 | -5 | -4 | | | | | | |
| 6 | 4-1 | Motion | EUI64-0080E10300051735 | -5 | -4 | | | | | | |
| 6 | 4-2 | Motion | EUI64-0080E103000526E7 | -5 | -4 | | | | | | |
| 6 | 4-3 | Motion | EUI64-0080E1030005119E | -5 | -4 | | | | | | |
| 6 | 4-4 | Motion | EUI64-0080E1030005112B | -5 | -4 | | | | | | |

| 6 | 4-5 | Motion | EUI64-0080E103000526FB | -5 | -4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 4-6 | Motion | EUI64-0080E10300052816 | -5 | -4 | | | | | |
| 6 | 5-1 | Motion | EUI64-0080E103000512F3 | -5 | -4 | | | | | |
| 6 | 5-1 | Motion Plus | EUI64-0080E103000451A3 | -3 | -4 | | | -10 | -3 | -5 |
| 6 | 5-2 | Motion | EUI64-0080E103000511A2 | -5 | -4 | | | | | |
| 6 | 5-2 | Motion Plus | EUI64-0080E10300045420 | -3 | -4 | | | -10 | -3 | -5 |
| 6 | 5-3 | Motion | EUI64-0080E10300051DF1 | -5 | -4 | | | | | |
| 6 | 5-4 | Motion | EUI64-0080E10300052522 | -5 | -4 | | | | | |
| 6 | 5-5 | Motion | EUI64-0080E103000516ED | -5 | -4 | | | | | |
| 6 | 5-6 | Motion | EUI64-0080E103000524B4 | -5 | -4 | | | | | |
| 7 | 7 | Motion Plus | EUI64-0080E103000452B7 | -3 | -4 | | | -10 | -3 | -5 |
| 8 | 8 | Motion Plus | EUI64-0080E1030004507E | -3 | -4 | | | -10 | -3 | -5 |
| 9 | 9 | Motion Plus | EUI64-0080E1030004542F | -3 | -4 | | | -10 | -3 | -5 |
| 9 | 6-1 | Motion | EUI64-0080E1030005133F | -5 | -4 | | | | | |
| 9 | 6-1 | Motion Plus | EUI64-0080E103000451A5 | -3 | -4 | | | -10 | -3 | -5 |
| 9 | 6-2 | Motion | EUI64-0080E10300051301 | -5 | -4 | | | | | |
| 9 | 6-2 | Motion Plus | EUI64-0080E10300045407 | -3 | -4 | | | -10 | -3 | -5 |
| 9 | 6-3 | Motion | EUI64-0080E10300051776 | -5 | -4 | | | | | |
| 9 | 6-4 | Motion | EUI64-0080E1030005264A | -5 | -4 | | | | | |
| 9 | 6-5 | Motion | EUI64-0080E10300051647 | -5 | -4 | | | | | |
| 9 | 6-6 | Motion | EUI64-0080E103000527B7 | -5 | -4 | | | | | |
| 10 | 10 | Comfort | EUI64-0080E103000478EA | -3 | | -4 | -6 | -10 | -3 | -5 |
| 10 | 10 | Motion Plus | EUI64-0080E103000454E9 | -3 | -4 | | | -10 | -3 | -5 |
| 11 | 11 | Comfort | EUI64-0080E1030004674E | -3 | | -4 | -6 | -10 | -3 | -5 |
| 11 | 11 | Motion Plus | EUI64-0080E10300045154 | -3 | -4 | | | -10 | -3 | -5 |
| 11 | 11-1 | Motion | N/A | [DEVICE]-5 | [DEVICE]-4 | | | | | |
| 12 | 8 | Comfort | EUI64-0080E10300046CF8 | -3 | | -4 | -6 | -10 | -3 | -5 |
| 12 | 12-1 | Motion Plus | EUI64-0080E103000457A1 | -3 | -4 | | | -10 | -3 | -5 |
| 12 | 12-2 | Motion Plus | EUI64-0080E103000452CD | -3 | -4 | | | -10 | -3 | -5 |
| 12 | 7-1 | Motion | EUI64-0080E10300052688 | -5 | -4 | | | | | |
| 12 | 7-2 | Motion | EUI64-0080E103000519D8 | -5 | -4 | | | | | |
| 12 | 7-3 | Motion | EUI64-0080E10300051B65 | -5 | -4 | | | | | |
| 12 | 7-4 | Motion | EUI64-0080E10300051340 | -5 | -4 | | | | | |
| 12 | 7-5 | Motion | EUI64-0080E10300051B04 | -5 | -4 | | | | | |
| 12 | 7-6 | Motion | EUI64-0080E1030005146B | -5 | -4 | | | | | |
| 12 | 8-1 | Motion | EUI64-0080E10300052466 | -5 | -4 | | | | | |
| 12 | 8-2 | Motion | EUI64-0080E103000511F9 | -5 | -4 | | | | | |
| 12 | 8-3 | Motion | EUI64-0080E10300052789 | -5 | -4 | | | | | |
| 12 | 8-4 | Motion | EUI64-0080E10300051A2F | -5 | -4 | | | | | |
| 12 | 8-5 | Motion | EUI64-0080E103000513A0 | -5 | -4 | | | | | |
| 12 | 8-6 | Motion | EUI64-0080E1030005134D | -5 | -4 | | | | | |
| 13 | 13 | Motion Plus | EUI64-0080E1030004515F | -3 | -4 | | | -10 | -3 | -5 |
| 13 | 9-1 | Motion | EUI64-0080E1030005171C | -5 | -4 | | | | | |
| 13 | 9-2 | Motion | EUI64-0080E103000527C8 | -5 | -4 | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 9-3 | Motion | EUI64-0080E103000519ED | -5 | -4 | | | | | | |
| 13 | 9-4 | Motion | EUI64-0080E10300051709 | -5 | -4 | | | | | | |
| 13 | 9-5 | Motion | EUI64-0080E10300051B3D | -5 | -4 | | | | | | |
| 13 | 9-6 | Motion | EUI64-0080E103000527A8 | -5 | -4 | | | | | | |
| 14 | 10-1 | Motion | EUI64-0080E10300024525 | -5 | -4 | | | | | | |
| 14 | 10-2 | Motion | EUI64-0080E10300022551 | -5 | -4 | | | | | | |
| 14 | 10-3 | Motion | EUI64-0080E10300024598 | -5 | -4 | | | | | | |
| 14 | 14-1 | Motion Plus | EUI64-0080E103000452B9 | -3 | -4 | | | -10 | -3 | | -5 |
| 14 | 14-2 | Motion Plus | EUI64-0080E103000457D9 | -3 | -4 | | | -10 | -3 | | -5 |
| 15 | 10-4 | Motion | EUI64-0080E10300023C37 | -5 | -4 | | | | | | |
| 15 | 10-5 | Motion | EUI64-0080E10300022A58 | -5 | -4 | | | | | | |
| 15 | 10-6 | Motion | EUI64-0080E103000246CE | -5 | -4 | | | | | | |
| 15 | 11-2 | Motion | EUI64-0080E10300022410 | -5 | -4 | | | | | | |
| 15 | 15-1 | Motion Plus | EUI64-0080E103000455C5 | -3 | -4 | | | -10 | -3 | | -5 |
| 15 | 15-2 | Motion Plus | EUI64-0080E10300045424 | -3 | -4 | | | -10 | -3 | | -5 |
| 16 | 16 | Comfort | EUI64-0080E103000476D5 | -3 | | -4 | -6 | -10 | -3 | -5 | |
| 16 | 16 | Motion Plus | EUI64-0080E1030004553E | -3 | -4 | | | -10 | -3 | | -5 |
| 17 | 17 | Comfort | EUI64-0080E10300046744 | -3 | | -4 | -6 | -10 | -3 | -5 | |
| 17 | 17 | Motion Plus | EUI64-0080E10300045452 | -3 | -4 | | | -10 | -3 | | -5 |
| 18 | 18 | Comfort | EUI64-0080E10300046D2A | -3 | | -4 | -6 | -10 | -3 | -5 | |