Oracle® Cloud

Using Oracle Internet of Things Production Monitoring Cloud Service

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Preface

Using Oracle IoT Production Monitoring Cloud Service provides information and procedures for using Oracle IoT Production Monitoring Cloud Service. Oracle IoT Production Monitoring Cloud Service lets you monitor and manage your production facilities.

Topics:

- Audience
- Documentation Accessibility
- Related Documents
- Conventions

Audience

Using Oracle Internet of Things Production Monitoring Cloud Service is intended for factory managers, maintenance technicians, and system administrators.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc.

Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info or visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs if you are hearing impaired.

Related Documents

For more information, see these Oracle resources:

- Oracle Cloud at http://cloud.oracle.com
- *Getting Started with Oracle Cloud*

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

1

Get Started with Oracle IoT Production Monitoring Cloud Service

Get started with Oracle IoT Production Monitoring Cloud Service. Learn how to access the cloud service.

Topics

- Before You Begin
- How to Access Oracle IoT Production Monitoring Cloud Service
- How to Get Support

Before You Begin

Before you begin using Oracle IoT Production Monitoring Cloud Service make sure that you have the following items.

- Make sure you have link to access Oracle IoT Production Monitoring Cloud Service and a user account. Typically these are included in your subscription email, if you haven't received this email, contact the system administrator. See How to Access Oracle IoT Production Monitoring Cloud Service.
- If you are a maintenance technician, install and configure the mobile app. See How to Access Oracle IoT Production Monitoring Cloud Service.
- If the application doesn't have any factories, or is missing data, contact your system administrator.
- If you are a system administrator, make sure that you have access to Oracle IoT Production Monitoring Cloud Service.
- If you are a system administrator, configure your devices and then upload the data before configuring anything else or using the application. See Configure Your Devices and Upload Your Data.

How to Access Oracle IoT Production Monitoring Cloud Service

Log in to the web application or to the mobile app to start using Oracle IoT Production Monitoring Cloud Service.

To log in to Oracle IoT Production Monitoring Cloud Service you must have a user account. Oracle provides user account information when you subscribe to the cloud service.

To access the web based application:

1. Open an internet browser and go to: `https://hostname/pm`

   You can find the name of your host in the email you received when you subscribed to the service.
2. Enter your user name and password.

3. Click **Sign In**.

To access the mobile app:

1. Open the App Store in your Apple device, or the Play Story in your Android Device.
2. Search for Oracle IoT Production Monitoring and install the mobile app.
3. Open the mobile app.
4. In the **IoT Server URL** field, enter the URL of the host for your Oracle IoT Production Monitoring Cloud Service instance.

   You can find the URL of your host in the email you received when you subscribed to the service.
5. Enter your user name and password.
6. Click **Sign In**.

How to Get Support

Use these resources to resolve problems:

- Visit the Oracle Help Center at http://docs.oracle.com/en/.
- If you're an Oracle Premier Support Customer, visit My Oracle Support.
- Contact Oracle Technical Support. See Contacting Oracle Support in *Getting Started with Oracle Cloud*.

2

Get to Know Oracle IoT Production Monitoring Cloud Service

Learn the basics about Oracle IoT Production Monitoring Cloud Service.

Topics

- Overview
- Understand the Different Personas
- What Chapters Should You Read?
- Work with the Map View

Overview

Oracle IoT Production Monitoring Cloud Service is a specialized Internet of Things application. This application lets you locate your factories and machines, and monitor their health and utilization. It gives you real-time visibility into your production process and helps you diagnose and predict production issues so that you can increase the uptime of your factories. It also helps you schedule maintenance so that you can minimize the disruption to your daily operations.

Oracle IoT Production Monitoring Cloud Service lets you monitor your shop floor in real time. The physical systems designed to manufacture products can communicate with each other , as well as interact and cooperate with humans. This interaction increases the efficiency of your production process and improves your decision-making process.

Stream data from the factory floor to measure the performance and health of you equipment based on different predefined or custom metrics, and get up-to-date production status information.

Monitor the performance of you factories at different levels, starting from a global perspective to then drill down to the health of specific machines:

- Factory Level: View all your production lines as they appear on your shop floor, and select a specific production line for more details.
- Product Level: Monitor the progress of your products, view diagrams product routing, and identify bottlenecks.
- Machine Level: View machine availability statistics, view the associated sensor data to identify problem areas, and identify machine issues that affect production output.

You can compare your factory or machine with the best performers, or view historical data to contextualize the current performance data. You can also monitor warnings that may anticipate future production issues, and monitor and track the current incidents and their resolution.

What are the Typical Use Cases?

The following table shows some of the industries that are currently using *Known Issues for Oracle IoT Production Monitoring Cloud Service* and lists the objectives they wanted to achieve when they chose the product.

Industry	Objectives
Pharmaceutical Manufacturing	• Reduce scrap rate. • Improve machine health tracking. • Increase uptime.
Consumer Electronics Manufacturing	• Improve the delivery process. • Increase the production line utilization. • Reduce scrap.
High-Tech Manufacturing	• Increase capacity utilization. • Reduce unplanned downtime.
Plastic Manufacturing	Deliver of multi-variant individualized products on time.

Understand the Different Personas

Oracle IoT Production Monitoring Cloud Service covers the needs of the different personas involved in the production process.

Each of different personas involved in the production process has different objectives:

Persona	Objectives
VP of SupplyChain	• Avoid product delivery delays. • Improve the accuracy of production plan across all factories. • Reduce production costs. • Improve product delivery. • Incorporate recommendations derived from real time production diagnostics.
VP of Manufacturing Operations	• Reduce production costs. • Improve product delivery. • Determine improvement candidates (factories, production lines, products, and machines) across all factories.
Factory Manager	• Reduce production costs. • Effectively meet production plans. • Monitor the factory in real time. • Diagnose production issues. • Improve overall machine health. • Track factories to deliver products per production plan. • Identify factories, products, and machines that need immediate attention • Understand current and predicted machine health to improve factory uptime.
Maintenance Technician	• Locate and identify the equipment that needs service. • View the prescribed actions to service this machine.

For the purpose of this document we will group the above personas into the following roles:

- Manager: this role includes VPs of Supply Chain, VPs of Manufacturing Operations, and factory managers.
- Maintenance Technician
- Application Administrator: the person in charge of uploading the data to the Cloud, configuring the factory sensors, and customizing the application.

What Chapters Should You Read?

Bookmark the chapters in this list for easy access.

Reading all of the chapters in this book will provide you a better knowledge of the product. However, depending on your role, some chapter will interest you and affect you more than others..

The following table lists the chapters you should focus on depending on your role:

Role	Chapters
Manager	• Get to Know Oracle IoT Production Monitoring Cloud Service • Monitor Your Factory in Real Time • Diagnose Production Issues • Understand Factory Performance
Maintenance Technician	• Use the Mobile App • Get to Know Oracle IoT Production Monitoring Cloud Service
Application Administrator	• Customize Your Application • Upload Your Data • Configure Your Devices

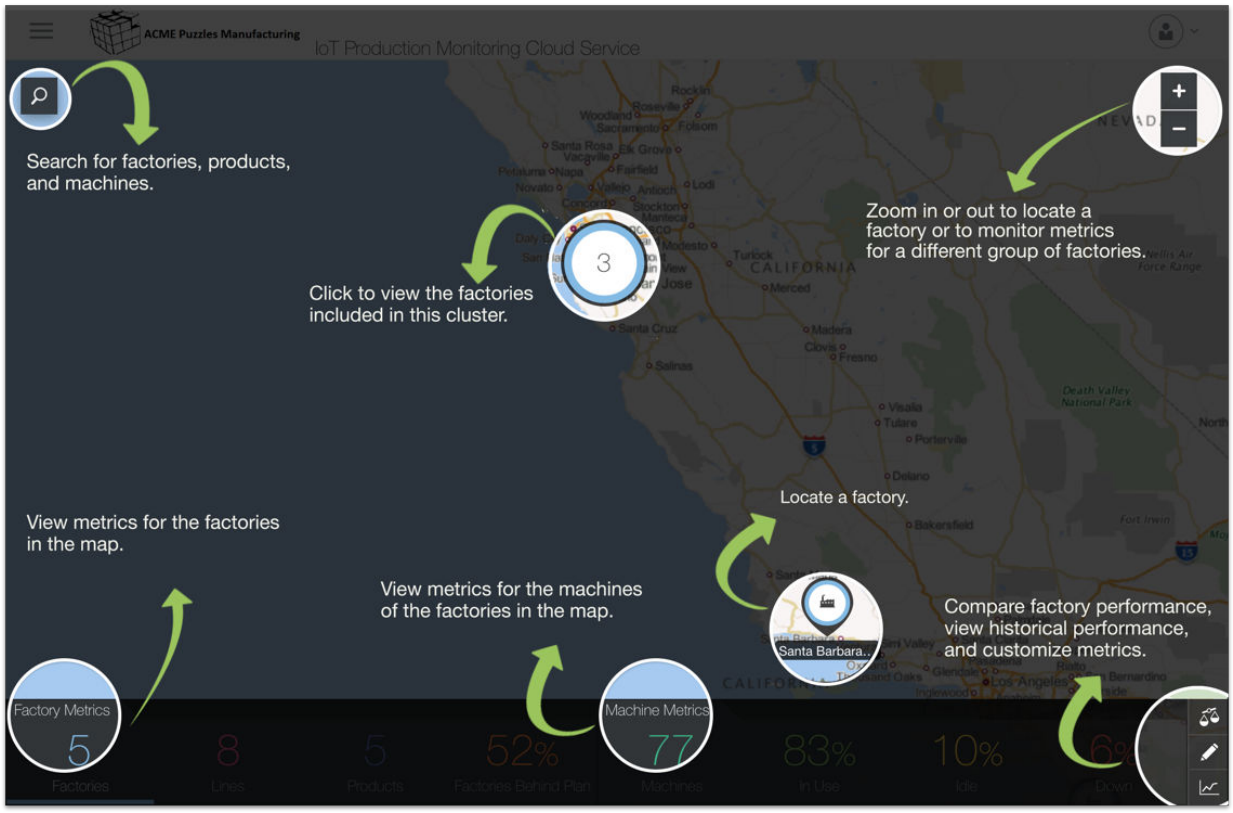
Work with the Map View

Use the **Map** view to locate your factories and monitor their performance. You can also view a comparison between your factories or view the historical values for the group of factories in the map.

The **Map** view gives you a general idea of the status and performance of all your factories. It lets you compare the performance over time and across factories.

If these general metrics indicate a performance issue, or if you want more details, you can drill down to view the data and metrics for a specific factory. Then from the factory view, you can also drill down to view a specific machine, production line, or product.

This image shows you how to use the **Map** view:



Search

Search for a specific factory, product, or machine. You can combine different search parameters to narrow your search.

Zoom

Zoom in our out to change the number of factories displayed in the map view. When you zoom in or out, the values for the factory and machine metrics change to include all the factories displayed in the map view.

Factory Metrics

Use these metrics to monitor a group of factories. These metrics give you a general idea of the performance and health of your factories. See What Are Metrics? and Monitor the Performance for a Group of Factories.

Machine Metrics

Use these metrics to monitor the machines in the group of factories displayed in the map view. These metrics let you view the statistics for the status of the machines in your factories. See What Are Metrics? and Monitor the Performance for a Group of Factories.

Comparative View

This view lets you compare the performance of your factory over a period of time. See Compare Your Factory to Other Factories.

Customize Metrics

Customize the colors of your available metrics, change their order, add new groups, or add new metrics. See Customize Existing Metrics and Define Your Own Metrics.

Historical Performance

This view shows the performance of your factory for the selected metric. It also shows the performance for the best factory so that you can compare your factories to the best performer. See View Historical Values for a Specific Metric.

Part I

Use Oracle Internet of Things Production Monitoring Cloud Service

This part contains the following chapters:

- Monitor Your Factory in Real Time
- Diagnose Production Issues
- Understand Factory Performance
- Use the Mobile App

3

Create and Manage Organizations

Organizations are digital twin versions of your business. These are digital placeholders for the various heterogeneous entities that you have in your business, the locations where these entities operate from, and the associated users of these entities.

Topics:

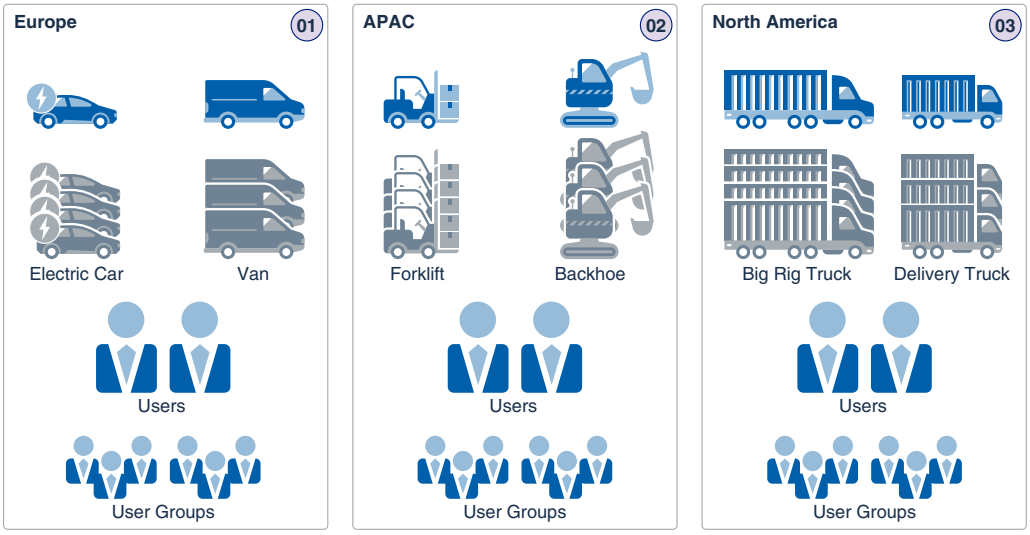
- About Organizations
- Create a New Organization
- Change Your Current Organization
- Assign Users to an Organization
- Export and Import Organizations

About Organizations

An organization contains digital versions of all the IoT-enabled assets that are part of your business operations. An organization is also associated with its authorized set of users. Predefined roles determine the privileges of each application user.

Your Oracle IoT Production Monitoring Cloud Service instance includes a default organization. All your factories, machines, operators, products and other entities are created in the default organization. You can create additional organizations if you need multiple business domains.

Your application can contain one or more organizations. For example, businesses often divide organizational operations based on geography. The following image shows a business divided into regions. Each region, Asia-Pacific, Europe, and North America has its own set of assets and users.



You may also want to have multiple organizations if you manage several clients, and you need to separate these clients into sub-tenants, so that each sub-tenant has its own set of assets and users.

Create a New Organization

Organizations are digital placeholders for the various heterogeneous entities that you have in your business, the locations where these entities operate from, and the associated users of these entities.

This operation is meant for application administrators only. Log in using the administrator account to create organizations in your application.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** (⟨) before you see the **Settings** option in the menu.
2. Click **IoT Organizations**, and then click **Manage Organizations**.
3. Click **Create Organization** in the Manage Organizations page.

   The Create Organization dialog appears.
4. Specify a **Name** for your organization.

   For example, *North America Operations.*
5. Specify an optional **Description.**
6. Click **Create**.

   The new organization is created along with its required artifacts. The operation status appears on the IoT Organizations page until the organization is ready for use.

Change Your Current Organization

If you are part of more than one organization, then you can change your current organization in the application.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **IoT Organizations**, and then click **Manage Organizations**.
3. Click **Switch Organization** in the Manage Organizations page.
4. Under **Switch To**, select the organization name that you wish to change to, and click **Switch**.

   The current organization is changed in the Design Center and Operations Center.

Assign Users to an Organization

Edit the organization to add or update the list of authorized users for the organization.

If you need to assign users to an organization other than your current organization, then make sure that you switch to the organization before performing the following steps. See Change Your Current Organization for more information on switching organization contexts.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **IoT Organizations**, and then click your organization name.
3. Click **User Access Control** on your organization page.
4. Under Users, select the users that you wish to include in the organization, and click the right-arrow icon ().

   The selected user moves to the list of authorized users.

   Tip: You can hold down the *Ctrl* key to select multiple users at a time.
5. Click **Save** to save the changes to the organization.

Export and Import Organizations

You can export an organization together with its constituent entities and settings. You can then import the organization into another Oracle IoT Production Monitoring Cloud Service instance.

When you export an organization, all constituents of the organization are exported. The factories, products, operators, machines, machine types, and the artifacts associated with the machine types, such as metrics, rules, anomalies, predictions, and trends are also exported. Any integration settings are also exported. Importing the organization into another instance creates the organization, together with its constituent entities, in the importing instance.

> **Note:**
>
> Import of organizations exported from previous releases is not supported. If you try to import a previously exported organization from an earlier release into the current release of Oracle IoT Production Monitoring Cloud Service, the import may fail.

Note that any devices connected to machines in the original instance are not included in the export. If you have machine types with mandatory sensor attributes, you would need to create new device links for the machines in the imported organization.

Export an Organization

Export an organization to create an `iot` export file containing the organization along with all its constituent entities and settings.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **IoT Organizations**, and then click **Manage Organizations**.
3. Click **Export Organization** in the Manage Organizations page.

   The Export Organization dialog appears.
4. Select the **Organization** that you wish to export, and click **Export**.

   A `.iot` archive of the organization is generated.
5. Save the generated `.iot` archive file to your hard disk or a storage location.

   You will use this file when importing the organization into another instance of Oracle IoT Production Monitoring Cloud Service.

Import an Organization

Import an organization into an Oracle IoT Production Monitoring Cloud Service instance to create the organizational artifacts previously exported from another instance.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **IoT Organizations**, and then click **Manage Organizations**.
3. Click **Import Organization** in the Manage Organizations page.

   The Import Organization dialog appears.
4. Under Upload File, click the **Drag and Drop** area to select a previously exported `.iot` archive file. Alternatively, you can also drag and drop the archive file to the **Drag and Drop** area in your browser window.
5. Click **Done.**

The organization is imported along with its containing artifacts. The organization appears in the list of existing organizations.

4

Create and Manage Users

Access to Oracle IoT Production Monitoring Cloud Service functionality is determined by pre-defined roles.

Log in using the administrator account to create users in Oracle IoT Production Monitoring Cloud Service and assign the required roles to them.

> **Note:**
>
> You can also use your Oracle Identity Cloud Service instance to manage users, and their assigned roles, for the registered Oracle IoT Production Monitoring Cloud Service application.
>
> You can access Oracle Identity Cloud Service from the My Services page of your cloud subscription.

Understand Roles and Users

Oracle IoT Production Monitoring Cloud Service uses predefined roles for the application users. Roles are a set of privileges assigned to a user.

Oracle IoT Intelligent Applications Cloud includes global and application-specific roles. Global roles apply across all your IoT applications, such as Asset Monitoring, Production Monitoring, Connected Worker, and Fleet Monitoring. Application specific roles are specific to a particular application, such as Production Monitoring.

Oracle Identity Cloud Service provides a centralized identity store for your Production Monitoring roles and users. When you create a user in Production Monitoring, the user is created and stored in the identity domain associated with your IoT application in Oracle Identity Cloud Service. You can grant one or more roles to a user.

Oracle IoT Production Monitoring Cloud Service uses the following roles:

- **Administrator (*IoTAdministrator*):** The administrator is responsible for the overall administration of the application. The Administrator role is a global superuser role applicable across Oracle IoT Intelligent Applications Cloud applications.

  The administrator sets up and maintains the application. The administrator:

  – Creates organizations.

  – Creates and manages users.

- **Factory Manager (*IoTFactoryManager*):** The factory manager is responsible for the overall operation of the factory. The factory manager creates factories, associated factory dashboards, and metrics.

  The factory manager:

  – Creates factories.

  - Creates machine types.
  - Imports machines from SCM Maintenance Cloud.
  - Creates machines.
  - Adds or removes metrics or KPIs.
  - Creates factory maintenance configurations, products, and operators.
  - Imports production lines, production plans, maintenance schedules, and routing tasks.
  - Creates maintenance schedules.
  - Creates rules.
  - Creates routing tasks.

- **Technician (*IoTTechnician*):** The technician is responsible for the onboarding and management of entities. This includes creating entity instances and configuring device connections. The technician also performs troubleshooting, and has access to the entity inventory, Digital Twin views, and incident updates.

  The Technician role is a global role applicable across Oracle IoT Intelligent Applications Cloud applications. The technician:

  - Onboards/Removes entities.
    * Creates/Deletes entity instances.
    * Configures connectivity:
      * Creates connectors.
      * Downloads schemas.
      * Creates interpreters.
  - Troubleshoots issues.
  - Resolves incidents:
    * Views related rules.
  - Accesses Digital Twin views:
    * Executes actions, what-if scenarios
  - Accesses entity inventories.
  - Edits custom attributes.

- **Machine Operator (*IoTMachineOperator*):** The machine operator is responsible for monitoring factory and machine metrics. The machine operator processes and updates work orders. The machine operator has read-only access to dashboards and metrics.

  The machine operator was called operator in pre-22.1.1 releases.

- **Viewer (*IoTViewer*):**The Viewer has read-only access to IoT applications. The Viewer role is a global role applicable across Oracle IoT Intelligent Applications Cloud applications.

  The Viewer role was called User in pre-22.1.1 releases. A viewer can access the following entities in Operations Center:

  - Dashboards
  - Digital Twins

– Notifications

A non-admin application user must have explicit Viewer role to be able to log into the management console (`/ui`).

Create a New User

To let a user access Oracle IoT Production Monitoring Cloud Service, create a new user in the application . Next, assign the roles appropriate for the user's assigned tasks.

1. In the Operations Center, click **Menu** (), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.

2. Click **User Management**.

3. Click **Create User** ().

4. Under **ROLES**, select one or more of these roles for the user from the **Common** and **Production Monitoring** sections:

   - **Administrator**
   - **Factory Manager**
   - **Technician**
   - **Machine Operator**
   - **Viewer**

   See Understand Roles and Users for detailed information on these application roles.

5. Under **NAME**, enter the name for the user and the desired User ID:

   - **First Name**: Enter the first name of the user.
   - **Last Name**: Enter the last name of the user.
   - **Username**: Enter a user name for the user account.

6. Under **EMAIL**, provide the email details for the user.

   - **Work**: Enter the work email address for the user.
   - **Home**: (Optional) Enter the home email address for the user.
   - **Recovery**: (Optional) Enter the recovery email address for the user. This email address is used to help the user regain access to their account if they forget their password or are locked out.
   - **Other**: Optionally, enter an additional email address for the user.

   A primary (work) email is required. Oracle Identity Cloud Service automatically sends a mail to this address with the link for user account activation.

7. (Optional) Under **TELEPHONE**, provide the telephone details for the user.

   - **Work**: Enter the work phone number for the user.
   - **Home**: Enter the home phone number for the user.
   - **Recovery**: Enter the recovery phone number for the user. This phone number is used to help the user regain access to their account if they forget their password or are locked out.

- **Other**: Enter an additional phone number for the user.
- **Mobile**: Enter the mobile phone number for the user.

8. Click **Save** and close the window to return to the User Management page.

After creating a new user, make sure you assign the user to the organization. See Assign Users to an Organization for more details.

Edit a User Account

Edit a user account to change the user's roles, name, e-mail, or telephone information.

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.

2. Click **User Management**.
3. Click **Edit** () against the appropriate user row.
4. Make the necessary changes under the **ROLES**, **NAME**, **EMAIL** and **TELEPHONE** sections.
5. Click **Save** and close the window to return to the User Management page.

Search for a User Account

Use the search function to locate a specific user account or user accounts matching specific search criteria.

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.

2. Click **User Management**.
3. Click **Filter**  to open the Filters dialog.
4. Click **Add** () to add new filter criteria.
5. Choose one of these options in the list:
   - **First Name**: Select this option to search for a user account by the user's first name.
   - **Last Name**: Select this option to search for a user account by the user's last name.
   - **Username**: Select this option to search for a user account by user name.
   - **Email**: Select this option to search for a user account by email address.
   - **Roles**: Select this option to search for a user account by role(s).
6. Enter your search criteria in the field and then press **Enter**.
7. (Optional) Click **Add** () to add additional filter criteria.

8. (Optional) Click **Remove** ( ) to remove a search criteria.
9. Click **Apply** to apply your search criteria.

About Operator Types

Operators are responsible for production-related operations, such as updating production plans and actual production quantities. You can create different operator categories for different production task types.

When creating a user in Oracle IoT Production Monitoring Cloud Service with the Operator (*IoTPMOperator*) role, you can specify the operator type for the new user.

When creating production plans, you can assign operator tasks to individual operators. The designated operators can also update actual production data, such as the *actual quantity* or *bad quantity* numbers.

Operators can also log in to the Oracle IoT Production Monitoring Cloud Service mobile application to see the work orders assigned to them, and to view or update production plans and routing task statuses.

Create an Operator Type

Create an operator type to define a new operator category.

1. Click **Menu** and then click **Design Center**.
2. Select **Operator Types** ( ) from the **Design Center** menu.
3. Click **Add** ( ).
4. Specify a **Name** to identify the operator type.
5. Specify an optional **Description** for the operator type.
6. Optionally click **Upload Image** to upload an image for the operator type.

   The chosen image is used in the operator information that appears for work order operations under the **Production** tab of the Factory view.
7. Click **Save** to save the new operator type.

Assign an Operator Type to a Machine Operator

To assign an operator type to a user with the machine operator role in Oracle IoT Production Monitoring Cloud Service, use the **Menu > Design Center > Operators** page.

Create a new user, as usual, and select the **Machine Operator** role for the user.

Navigate to **Menu > Design Center > Operators**, and click **Add** to add an entry for the operator.

Select the **User Name**, select a preexisting **Operator Type** for the user, and select an operator **Status**. For example, a *PrinterOperator* operator, whose status is *Working*.

5

Monitor Your Factory in Real Time

Monitor your factories in real time to immediately identify any issues that may delay or interrupt your production process.

Topics

- What Are Metrics?
- Monitor the Performance for a Group of Factories
- Monitor a Specific Factory
- Monitor the Performance of a Specific Factory
- Create a Digital Birth Certificate
- Monitor a Specific Machine
- View Machine Info and Sensor Data for a Machine

What Are Metrics?

Metrics are key values that you can track in your factories and machines to have a better understanding of their performance and health.

These key values are often referred to as key performance indicators. You can monitor metrics for a group of factories or for a specific factory.

Monitoring these metrics helps you identify and investigate any issues that may affect the performance of you factory. For example if the number of factories behind plan increases, you can identify which are the factories that are behind plan and then look at the metrics for the machines in that factory to understand which machine is causing the issue.

Your instance comes with a predefined set of metrics, but you can define your own metrics, and customize the existing ones. For more information on how to define your own metrics, see Define Your Own Metrics.

View Metrics in the Map View

In the **Map** view, the **Metrics** toolbar shows the values for all the factories that appear in the map. To view the metrics for more factories, zoom out until all the factories that you want to monitor appear in the map. If you want to see the values for just a group of factories, zoom in until you only see those factories in the map.

When you click the metrics value, the factoy icons in the map display the value of that metric for each factory or cluster of factories. See Monitor the Performance for a Group of Factories.

View Metrics for a Specific Factory

When you view a specific factory, the **Metrics** toolbar shows you the values for that factory. Use these metrics to identify the cause of your production issue. From the factory view you can locate the machine that is not performing as expected.

View Metrics for a Specific Machine

In the factory view you can click a specific machine to view the metrics for that machine and understand what caused the production issue.

Predefined Factory and Machine Metrics

System-defined factory and machine metrics appear at various places, such as in the map view KPI bar, organization level dashboards, and in factory and machine dashboards. You can also manually add these metrics to your dashboards, and use them in your custom metric computations.

Factory and Machine Metrics with Their Descriptions and Views

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Behind Plan Percentage	Factory Metric	Percentage of products that are behind plan.	**Yes.** Shows the percentage of products that are behind plan across factories in the current map location.	**Yes.** Shows the percentage of products that are behind plan across factories in the organization.	**Yes.** Shows the percentage of products that are behind plan in the factory.	**Yes.** Shows the percentage of products that are behind plan in the factory.
Behind Plan Percentage	Machine Metric	Percentage of products that are behind plan for the machine.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the percentage of products that are behind plan across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the percentage of products that are behind plan across factories in the organization.	**Yes.** Shows the percentage of products that are behind plan across machines in the factory.	**Yes.** On the machine dashboard, shows the percentage of products that are behind plan for the machine.
Count	Factory Metric	Total number of factories.	**Yes.** Shows the total number of factories in the current map location.	**Yes.** Shows the total number of factories in the organization.	Not Applicable.	Not Applicable.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Count	Machine Metric	Total number of machines.	**Yes.** Shows the total number of machines in the current map location.	**Yes.** Shows the total number of machines in the organization.	**Yes.** Shows the total number of machines in the factory.	**Yes.** Shows the total number of machines in the factory.
Down Percentage	Machine Metric	Percentage of machines that are down.	**Yes.** Shows the percentage of machines that are down across factories in the current map location.	**Yes.** Shows the percentage of machines that are down across factories in the organization.	**Yes.** Shows the percentage of machines that are down in the factory.	**Yes.** Shows the percentage of machines that are down in the factory.
Down Status	Machine Metric	Count/ Percentile of machines that are down.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the count/ percentile of machines that are down across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the count/ percentile of machines that are down across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the count/ percentile of machines that are down in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the count/ percentile of machines that are down in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Factory Inactive Duration	Factory Metric	Time duration, in milliseconds, since the application last heard from any machine in the factory.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from factories across the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the time duration, in milliseconds, since the application last heard from any machine in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the time duration, in milliseconds, since the application last heard from any machine in the factory.
Idle Percentage	Machine Metric	Percentage of machines that are idle.	**Yes.** Shows the percentage of machines that are idle across factories in the current map location.	**Yes.** Shows the percentage of machines that are idle across factories in the organization.	**Yes.** Shows the percentage of machines that are idle in the factory.	**Yes.** Shows the percentage of machines that are idle in the factory.
In Use Percentage	Machine Metric	Percentage of machines that are in use.	**Yes.** Shows the percentage of machines that are in use across factories in the current map location.	**Yes.** Shows the percentage of machines that are in use across factories in the organization.	**Yes.** Shows the percentage of machines that are in use in the factory.	**Yes.** Shows the percentage of machines that are in use in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Machine Inactive Duration	Machine Metric	Time duration, in milliseconds, since the application last heard from the machine.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from machines across the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the avg/max/min/ sum/ percentile of the time durations, in milliseconds, since the application last heard from machines in the factory.
Machines Down Count	Factory Metric	Total number of machines that are down.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of down machines across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of down machines across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of down machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of down machines in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Machines Idle Count	Factory Metric	Total number of machines that are idle.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of idle machines across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of idle machines across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of idle machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of idle machines in the factory.
Machines In Use Count	Factory Metric	Total number of machines that are in use.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of in-use machines across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of in-use machines across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of in-use machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of in-use machines in the factory.
On Time Delivery Percentage	Factory Metric	Percentage of products that are delivered on time.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the percentage of products that are delivered on time across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the percentage of products that are delivered on time across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the percentage of products that are delivered on time for the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the percentage of products that are delivered on time for the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
On Time Delivery Percentage	Machine Metric	Percentage of products that are delivered on time.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the percentage of products that are delivered on time across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the percentage of products that are delivered on time across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the percentage of products that are delivered on time across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the percentage of products that are delivered on time across machines in the factory.
Overall Equipment Effectiveness (OEE)	Factory Metric	Average overall equipment effectiveness across factories.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the average overall equipment effectiveness across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the average overall equipment effectiveness across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the average overall equipment effectiveness of the factory.	**Yes.** Shows the average overall equipment effectiveness of the factory.
Overall Equipment Effectiveness (OEE)	Machine Metric	Average overall equipment effectiveness across machines.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the average overall equipment effectiveness across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the average overall equipment effectiveness across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the average overall equipment effectiveness across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the average overall equipment effectiveness across machines in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Pending Work Orders	Factory Metric	Number of work orders pending completion.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the sum/min/max/avg/percentile of work orders pending completion across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of work orders pending completion across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the sum/min/max/avg/percentile of work orders pending completion in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of work orders pending completion in the factory.
Pending Work Orders	Machine Metric	Number of work orders pending completion.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the sum/min/max/avg/percentile of work orders pending completion across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of work orders pending completion across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the sum/min/max/avg/percentile of work orders pending completion across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of work orders pending completion across machines in the factory.
Product Count	Factory Metric	Total number of products with production plans.	**Yes.** Shows the total number of products with production plans across factories in the current map location.	**Yes.** Shows the total number of products with production plans across factories in the organization.	**Yes.** Shows the total number of products with production plans in the factory.	**Yes.** Shows the total number of products with production plans in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Product Count	Machine Metric	Total number of products with production plans.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of products with production plans across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of products with production plans across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of products with production plans across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of products with production plans across machines in the factory.
Production Complete Quantity	Factory Metric	Total number of complete products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of complete products produced across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of complete products produced across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of complete products produced in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of complete products produced in the factory.
Production Complete Quantity	Machine Metric	Total number of products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of products produced across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of products produced across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of products produced across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of products produced across machines in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Production Reject Quantity	Factory Metric	Total number of reject products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of reject products produced across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of reject products produced across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of reject products produced in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of reject products produced in the factory.
Production Reject Quantity	Machine Metric	Total number of reject products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of reject products produced across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of reject products produced across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of reject products produced across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of reject products produced across machines in the factory.
Production Scrap Quantity	Factory Metric	Total number of scrap products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of scrap products produced across factories in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of scrap products produced across factories in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of scrap products produced in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of scrap products produced in the factory.

Metric Name	Factory or Machine Metric?	Description	Available in Org View KPI Bar?	Available in Org View Dashboard?	Available in Factory View KPI Bar?	Available in Factory Dashboard?
Production Scrap Quantity	Machine Metric	Total number of scrap products produced.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the total number of scrap products produced across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the total number of scrap products produced across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the total number of scrap products produced across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the total number of scrap products produced across machines in the factory.
Production Line Count	Factory Metric	Total number of production lines.	**Yes.** Shows the total number of production lines across factories in the current map location.	**Yes.** Shows the total number of production lines across factories in the organization.	**Yes.** Shows the total number of production lines in the factory.	**Yes.** Shows the total number of production lines in the factory.
Slippage	Machine Metric	Measure of production slippage due to down/idle status across machines.	You can optionally add from **Design Center > Organization > KPI Bar**. Shows the sum/min/max/avg/percentile of production slippage due to down/idle status across machines in the current map location.	You can optionally add from **Design Center > Organization > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of production slippage due to down/idle status across machines in the organization.	You can optionally add from **Design Center > Factory > *FactoryName* > KPI Bar**. Shows the sum/min/max/avg/percentile of production slippage due to down/idle status across machines in the factory.	You can optionally add from **Design Center > Factory > *FactoryName* > Dashboards > Main Dashboard**. Shows the sum/min/max/avg/percentile of production slippage due to down/idle status across machines in the factory.

Define Your Own Metrics

Define custom metrics to monitor indicators that are meaningful to you and that help you understand the status of your factories and machines.

You must create a new metric before adding it to the Map view toolbar or the factory view toolbar.

Create a new metric:

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Metrics**.
4. Click **Create Metric** .
5. Enter a **Name** to identify the new metric.
6. Select the **Entity Type** to which the metric applies.

   The **Entity Type** is usually the machine type. You have the following options:

   - **All Factories**: Select if your metric applies to all factories. For example, a metric that calculates the percentage of machines that are down per factory.
   - **All Machines**: Select if your metric applies to all machines. For example, a metric that calculates the average production quantity per machine.
   - **Production Plans**: Select if your metric applies to production plans. For example, a metric that calculates the hourly average of actual quantities produced for a particular routing task.
   - **Maintenance Schedules**: Select if your metric applies to maintenance schedules. For example, a metric that queries the maintenance start times and end times.
   - **Machines:** Lists the various machine types available. Select the machine type if you are creating a metric that applies to a machine type. For example, a metric that calculates the average dispensation rate for a dispenser machine.
   - **Work Orders**: Select to use work order data attributes in your metric formula. For example, a metric that calculates the reject quantity produced for a product, as a percentage of the total quantity produced.
7. Under **Calculation Scheduling**, select an appropriate option.
   - **On Demand:** On-demand metrics get calculated when they appear on a page, such as the Map page. On-demand metrics use less computational resources. You cannot use an on-demand metric for anomalies, predictions, and historical analysis.
   - **On Schedule:** Scheduled metrics are refreshed at the intervals you specify. You can choose between weekly, daily, hourly, and live metrics. Scheduled metrics can be used in anomalies, predictions, and historical analysis.

     Metrics can be calculated per entity (machine), or can be calculated globally for an entity type (machine type).
8. If creating a scheduled metric, specify a calculation **Schedule**:

- **Live** calculates the metric every two minutes.

  Use this option sparingly, as it may require a lot of computational and storage resources depending on your number of machines. The **Live** option may be used in special circumstances: For example, when the metric is to be used for anomaly detection purposes.

- **Hourly** aggregates the metric for every hour.
- **Daily** aggregates the metric for every day.
- **Weekly** aggregates the metric for every week.

9. (Optional) For scheduled metrics, click **Edit** to change the **Data Window** to use.

   By default, the **Data Window** is the same as the calculation schedule. For example, if you have set the metric schedule to **Hourly**, the data from the previous hour is used to calculate the metric.

   You can also use flexible data windows for your scheduled metric calculations. The data window can be different from the calculation schedule. For example, you may wish to compute the total output for the past twenty-four hours, and calculate this metric hourly.

   In addition to sliding data windows, you can also use dynamic custom data windows. For example, you may wish to do an hourly calculation of the cumulative output for the day, starting 9 a.m. in the morning.

   a. Select a **Configuration** value:

      - **Default**: Uses the default data window as per the selected schedule. For example, if you have set the metric schedule to **Hourly**, the data from the previous hour is used to calculate the metric.
      - **Data Window Start Time**: Lets you pick from a number of fixed options. For example, you may use data from the last one week, and calculate the metric hourly.
        When choosing larger data windows, ensure that the data life span settings for your custom metrics are large enough in the application settings, so that there is data available for the selected window.
      - **Custom Data Window Start Time**: Lets you choose a fixed start time for the data window. For example, you may wish to do an hourly calculation of the cumulative output for the day, starting 9 a.m. in the morning.
        This option is only available when selecting the **Live** or **Hourly** schedule.

   b. Select the **Data Window** value corresponding to the selected configuration:

      - If you selected **Default**, the **Data Window** is automatically selected to match the metric calculation schedule.
      - If you selected **Data Window Start Time**, specify the **Offset** to use. For example, choose **One Week Ago**, to use the data from the past one week.
      - If you selected **Custom Data Window Start Time**, then specify the fixed start **Time** for the data window in the **UTC** (Coordinated Universal Time) time zone.

10. Using the **Formula** editor, define an expression to calculate the new metric.

    You can build your operation using the elements in the Formula editor, or click **Advanced** to directly edit the SQL-like expression.

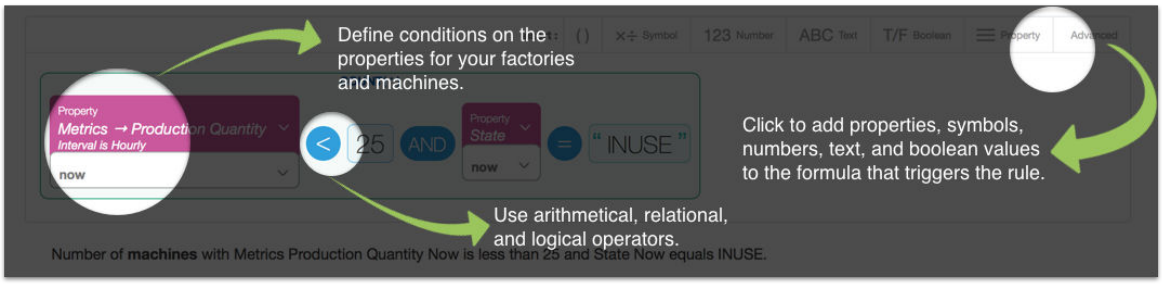
    The default formula uses the Count function on the properties you choose. So, for example, you may want a count of the number of factories with pending work orders greater than 10.

To select a different function or aggregation, click the function name (**COUNT**), select the function name, and choose from the properties available for the selected function. The following additional functions are available:

- SUM
- AVERAGE
- MIN (Minimum)
- MAX (Maximum)

Build your expression using the toolbar in the Formula editor, or by typing in the expression.

This image shows you how to use the formula editor:



Your expression can contain the following elements:

- Parenthesis: Use parenthesis to group operations and indicate precedence.
- Symbols: You can use arithmetic, relational, and logic operators. When you click the Symbol button, the add operator appears in our formula. If you want to select another operator, click the add icon and select an operator from the list.
- Numbers, text, and boolean values.
- Properties: A list of predefined indicators that you can use to build your own metrics. This list is based on the business entity that you selected.

The description for the metric is automatically created based on the properties and operators that you select.

11. (Optional) Click **Validate Formula** to validate your expression.
12. (Optional) Under Testing, click **Run Test** to view sample metric results on live machine data.

> **Note:**
>
> You must successfully validate the formula before **Run Test** is enabled.

Sampling the metric values lets you validate whether your computations work along expected lines. Sampling also lets you determine if the metric can go live, and if the metric is ready to be used in analytics artifacts, such as anomalies and predictions.

Computations are made using live data scheduling. Results may take a few minutes to compute and are available for two hours. Metric results may be shown for a sample selection of machines to cover the range of metric values.

13. Click **Save**.

    Your metric is saved and you can add it to the toolbar in the Map view.

Add the new metric to the Metrics toolbar in the Map view:

14. In the **Map** view, click the **Edit** icon located in the **Metrics** toolbar.
15. Drag and drop your new metric from the **Unused Metrics** group to an existing group.

    To drag and drop a metric, click on the ... located above the metric's value.

    You can add your metric to an existing group, or create a new one by clicking the Add icon next to the existing groups.

Use Duration Tracker Metrics

Duration tracker metrics let you track machine state durations based on the conditions you specify. The metric conditions can use sensor attribute values, dynamic attribute values, and other user-defined or system-defined metrics.

Your manufacturing scenario may require you to track the duration of time for which a machine remains inactive, or sensor attribute values remain out of range.

Like formula-based metrics, you can add duration tracker metrics to your dashboards. You can also use duration tracker metrics in your rule conditions to generate incidents, warnings, and alerts if a threshold duration is crossed.

For example, you may wish to track the time duration for which the pressure sensor readings remain out of range. You can create a duration-based metric and add it to the machine dashboard. You can also create a rule to generate a warning or an incident if the sensor values remain out of range beyond the threshold duration that you specify.

Create a Duration Tracker Metric

The metric editor can be used to create a duration tracker metric for one or more machines of a machine type.

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** sub-menu.
3. Select a machine type from the **Machine Types** list.

   You can also search for a machine type.
4. Click **Metrics**.
5. Click **Create Metric** +.
6. Enter a **Name** to identify the new metric.
7. (Optional) Enter a **Description** for the metric.
8. Select **Duration Based** under **Metric Type**.
9. (Optional) Select a value under **Keep Metric Data For**.

If you have unique storage requirements for historical data related to this metric, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

For example, if you are calculating frequent metrics across a large number of machines, and the metric data is not required beyond a week, then you can select **7 Days** under **Keep Metric Data For** to optimize storage.

10. Select a **Mode** for the duration based metric:
    - **Live:** The time duration for which the metric conditions are currently being met. If the metric conditions are currently not met, then the **Live** value is zero.
    - **Last:** The time duration for which the metric conditions were last met. When the metric conditions go from *currently being met* to *currently not being met*, the value of **Live** is transferred to **Last**, and the **Live** value becomes zero.
    - **Cumulative:** The total time duration of all occurrences when the metric conditions were met.
      If you select **Cumulative**, you also need to select a **Time Window**. The cumulative occurrences are tracked over the **Time Window** you select. For example, if you select **Weekly**, then the total time duration of all occurrences over the past week is tracked.

    You can select more than one mode if required.
11. Under **Target**, select **All Machines of Type: `MachineType`** to calculate the metric for each machine of the machine type. Alternatively, select **Specific Machines of Type: `MachineType`** and click **Select** to select one or more machines that you wish to monitor.

    You can hold down the **Ctrl** key to select more than one machine name.
12. Under **Conditions**, add one or more conditions.

    You can create threshold conditions based on whether a sensor attribute, or pre-existing metric, exceeds a set threshold. You can create threshold conditions for dynamic attributes, too.

    To create a threshold condition:

    a. Select a machine sensor attribute or existing metric from the drop-down list.

    b. Select a threshold condition for the attribute in the second drop-down list.

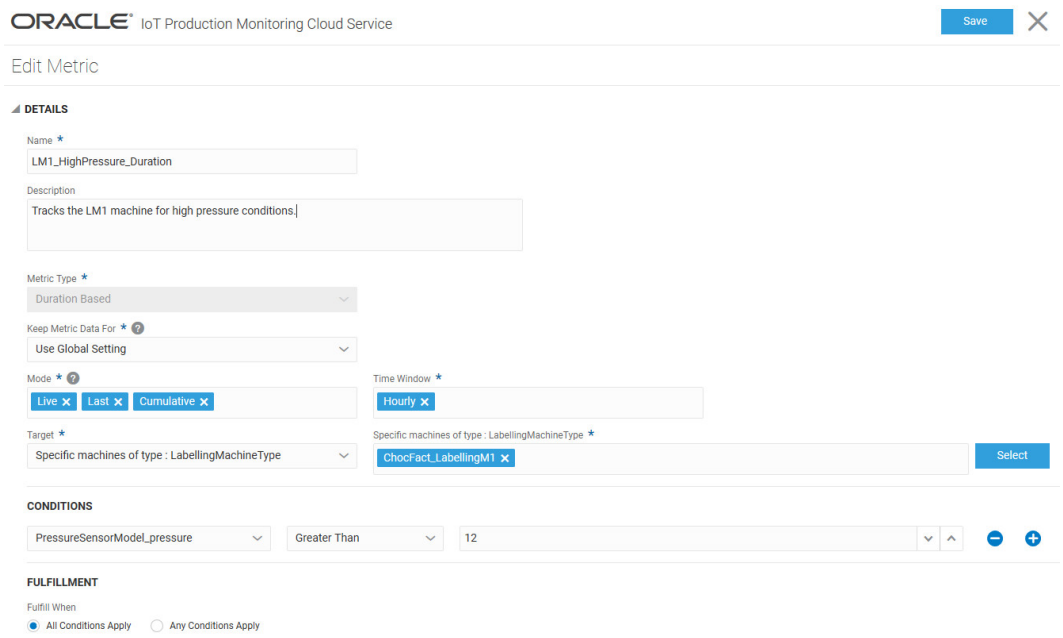
       For example, a numeric attribute specifies conditions like **Greater Than** and **Less Than.**

    c. Specify an attribute value in the third field.

       For example, a complete condition may look like: `maxtemp Greater Than 50.`

       A complete condition that uses a system metric may look like: `sys_machineInactiveDuration Greater Than 60000.` Here, 60,000 milliseconds represent 60 seconds.
13. (Optional) Add additional conditions, as required.
14. In the Fulfillment section, select an option for the **Fulfill when** field:
    - **All Conditions Apply** : Select this option to track the duration when all the conditions are met.

- **Any Conditions Apply**: Select this option to track the duration when any of the conditions are met.



The preceding example shows the metric editor for a duration-based metric. The duration is tracked when the pressure sensor reading is greater than 12.

15. Click **Save** to create the metric.

You can next add the newly created metric to your dashboards, or use the metric in rule conditions.

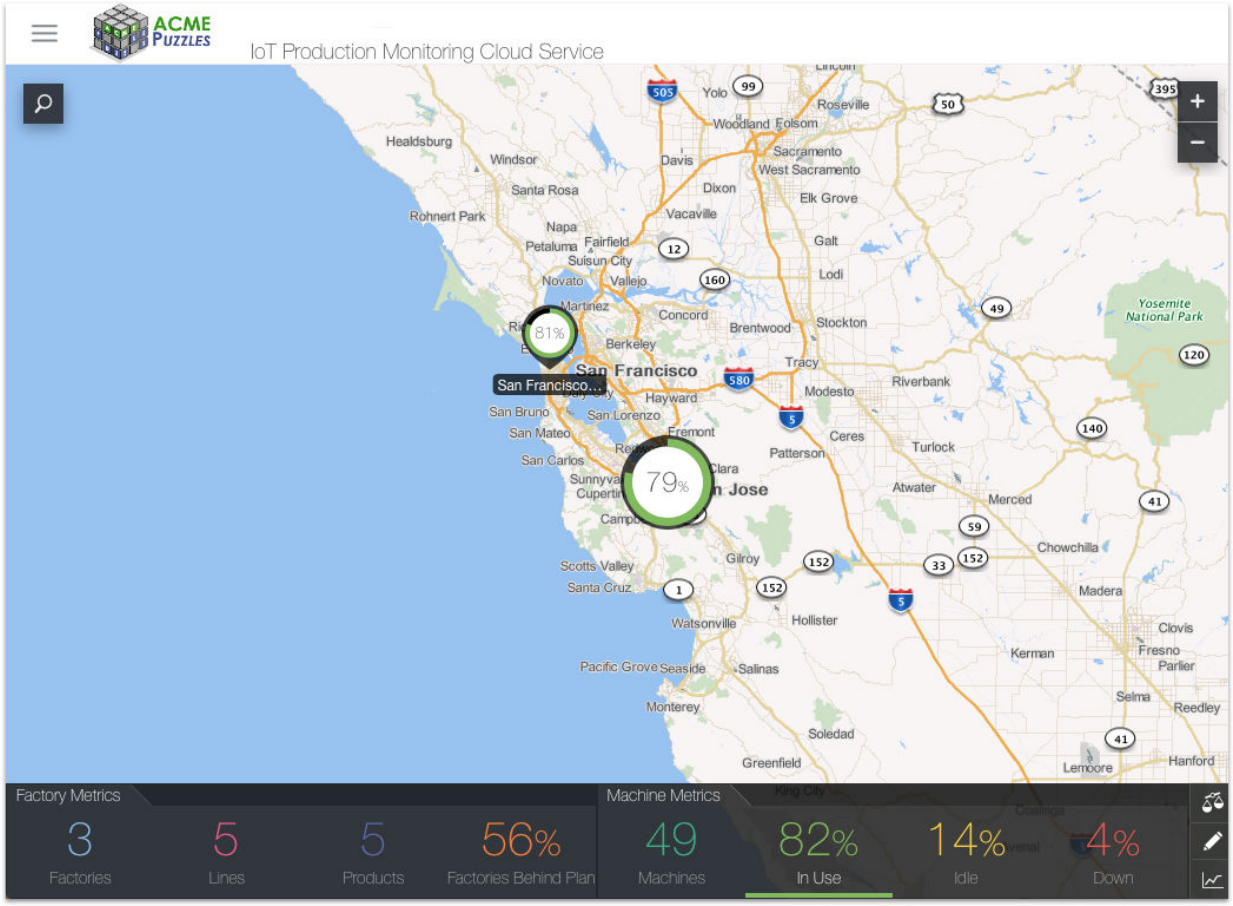
Monitor the Performance for a Group of Factories

You can monitor various metrics for all the factories displayed in the map. You can also view how the different factories contribute to the total value for a certain metric.

In the map view zoom in our zoom out include all the factories you want to monitor in the map. The **Factory Metrics** and **Machine Metrics** will display the values for all the factories displayed in the map.

You can click each metric to see how the different factories participate in that total value.

The following image shows the **Map** view with an individual factory and a cluster containing multiple factories. The **In Use** metric is selected, so the factory and the cluster of factories display the percentage of machines that are currently manufacturing products.



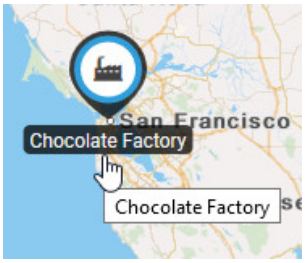
Depending on the metric you select, the factory icons and the clusters of factories display the following:

Metric	Type	Displayed Value
Factories	Factory	The number of factories included in each cluster on the map.
Lines	Factory	The number of production lines available for each individual factory or cluster of factories.
Products	Factory	The number of different products produced in an individual factory or cluster of factories.
Factories Behind Plan	Factory	The percentage of the projected production output that was not fulfilled for that individual factory or cluster of factories.
Machines	Machine	The total number of machines in that individual factory or cluster of factories.
In Use	Machine	The percentage of machines that are in use for that individual factory or cluster of factories.
Idle	Machine	The percentage of machines that are idle for that individual factory or cluster of factories.
Down	Machine	The percentage of machines that is unavailable for that individual factory or cluster of factories. Machines can be unavailable due to maintenance or mechanical issues.

Monitor a Specific Factory

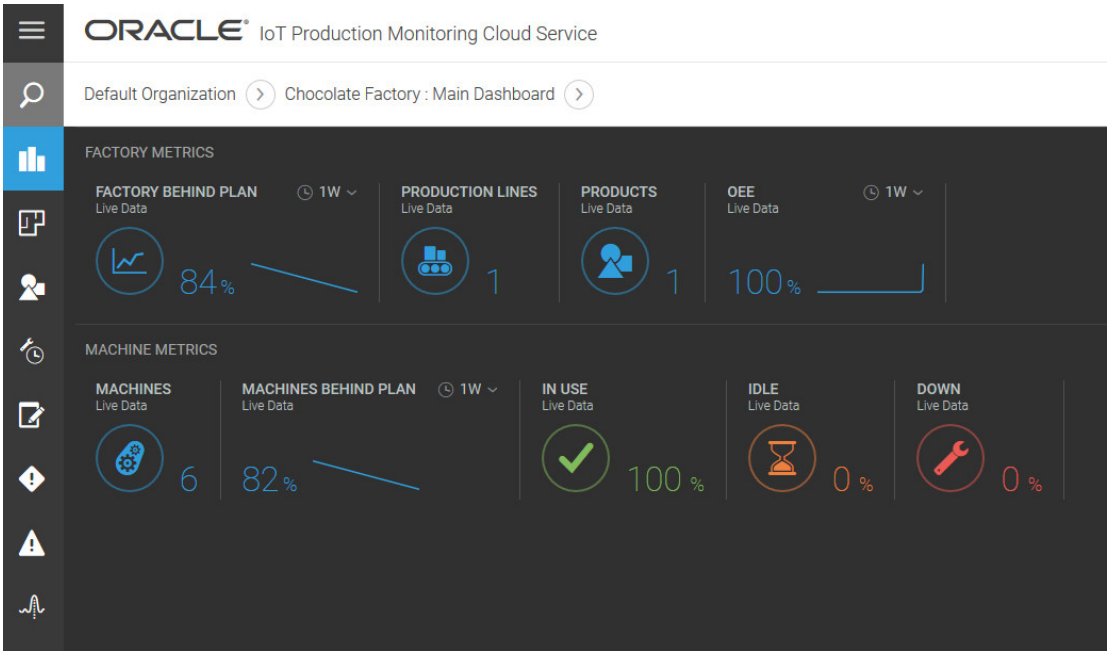
For each of your factories, you can view the factory metrics and machine metrics on the main dashboard. You can also see the floor plan, maintenance schedules, incidents and warning reports, product routing data, the digital birth certificate, and anomalies for the factory.

Locate your factory in the Operations Center **Map** view. You might need to zoom in our out, and click to expand clusters of factories until you find your factory. Click your factory icon in the map.



The main dashboard for the factory appears by default.

> **Note:**
>
> You can change the visualization options in the factory settings if you want a different page to appear by default. For example, you may want the floor plan page to appear as the default view.



The ready-to-use dashboard includes common factory and machine metrics. You can include other system metrics by editing the dashboard in the Design Center. For example, you can add system metrics for the number of completed or reject product quantities. You can also add custom metrics to the dashboard.

> **Note:**
>
> You can create additional custom dashboards in the Design Center.

Several metrics have accompanying charts. Click a chart to open it in a pop-up window. You can choose predefined or custom time periods for your charts.

> **Note:**
>
> When selecting time periods for your sensor and metric charts, the values available depend on the data life spans for your sensor and metric data. You can view data up to a maximum of six months if the storage life span for your sensor and metric data exceeds six months.

In addition to the main dashboard, there are several tabs, or views, available for your factory. The following table summarizes these tabs.

Tab Name	Icon	Description
Main Dashboard		View the factory metrics and overall machine metrics at a glance. You can customize the factory dashboard in the Design Center to add or remove metrics.
Floor Plan		View how the machines are distributed in your factory. You can select different metrics to see how your machines contribute to the toal value, see Monitor the Performance of a Specific Factory.
Incidents		View the incidents report for this factory. You can filter the list of warnings by specifying one or more search parameters.
Warnings		View the warnings report for this factory. You can filter the list of warnings by specifying one or more search parameters.
Production		View the machines involved in the production of a specific product. You can also monitor the different metrics for a specific product and product line to understand how the different machines contribute to the total value of that metric. See Monitor the Performance of a Specific Factory.
Reports		Create a digital birth certificate to track the production of each machine for a certain product in a specific period of time. See Create a Digital Birth Certificate.
Anomalies		View the anomalies report for that factory over a certain period of time.

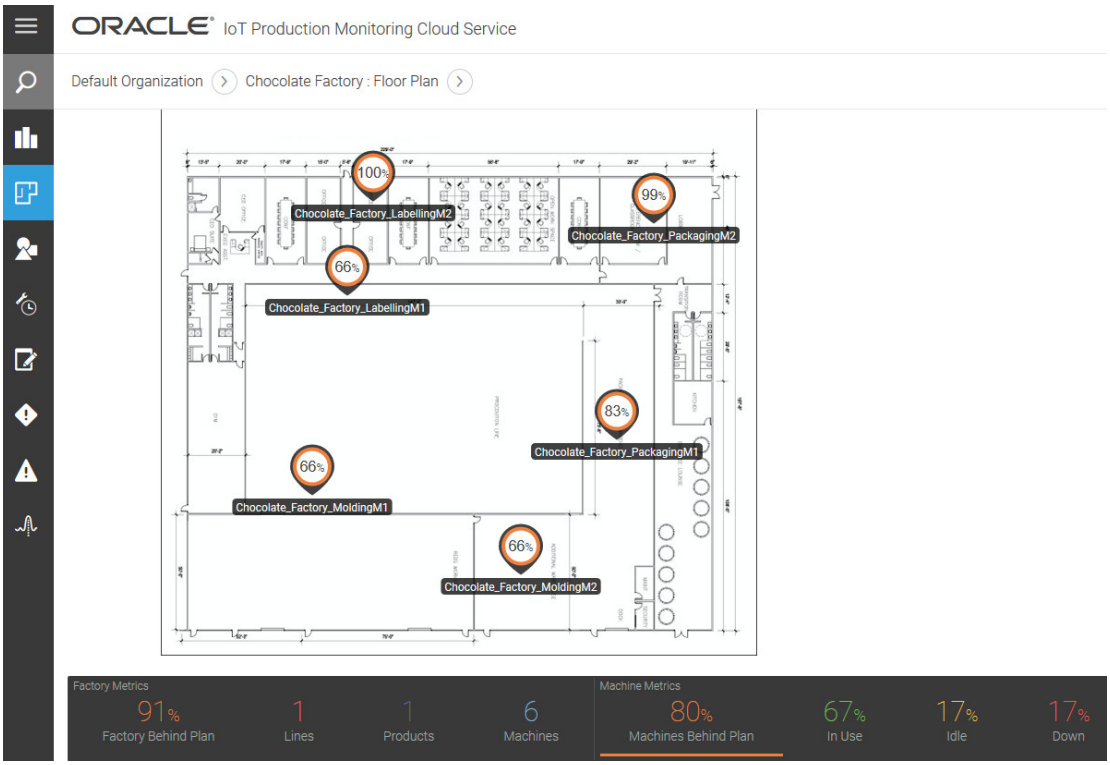
Tab Name	Icon	Description
Search		Lets you search for factories, machines, and locations.

Monitor the Performance of a Specific Factory

View the metrics for a specific factory and understand how the machines in that factory contribute to that metric.

In the **Floor Plan** view or in the **Production** view, you can click each metric to see how the different machines participate in the total for a specific metric.

The following image shows the floor plan view for the Chocolate Factory. The **Machines Behind Plan** metric is selected, so the floor plan shows how each of those machines contribute to the total of that metric. Each machine icon shows a percentage. The percentage indicates how much of the projected production output for the machine is yet to be fulfilled.



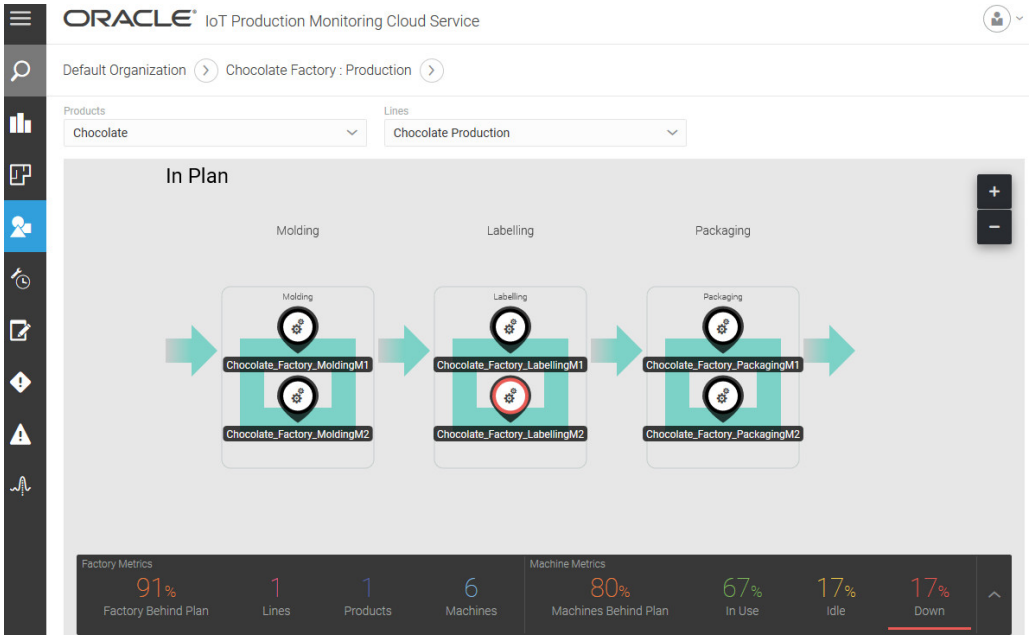
Depending on the metric you select, the machine icons display the following:.

Metric	Type	Displayed Value
Machines Behind Plan	Machine	The percentage of the projected production plan for the machine that remains to be fulfilled.

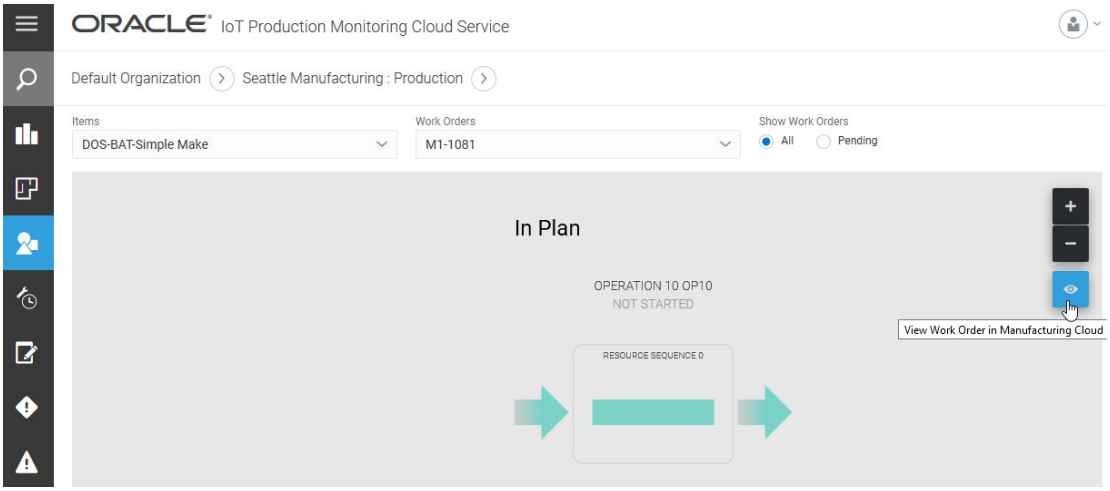
Metric	Type	Displayed Value
In Use	Machine	Shows the percentage of machines in use. If you select this metric, the machines that are currently in use are highlighted in the floor plan diagram with the same color used for the **In Use** metric. The machines that do not correspond to this metric are shown in gray.
Idle	Machine	Shows the percentage of idle machines. If you select this metric, the machines that are currently idle are highlighted in the floor plan diagram with the same color used for the **Idle** metric. The machines that do not correspond to this metric are shown in gray.
Down	Machine	Shows the percentage of machines that are currently unavailable. If you select this metric, the machines that are currently unavailable are highlighted in the floor plan diagram with the same color used for the **Down** metric. The machines that do not correspond to this metric are shown in gray.

The **Production** view shows the product routing information, which is the route a certain product follows in a certain product line. You can view the different stages of the production process and the machines allocated for the manufacturing of the product.

The following image shows the **Production** view for the chocolate production line. The **Down** metric is selected. This highlights the machines that are currently out of production.



The following image shows the **Production** view for a factory imported from Oracle Fusion Cloud Manufacturing. Notice that you can select the production item and work order to see the product routing information.



If you wish to open a work order directly in Oracle Fusion Cloud Manufacturing, you can use the **View Work Order in Manufacturing Cloud** button . A new browser tab opens the work order page in Oracle Fusion Cloud Manufacturing. You may need to log in to Oracle Fusion Cloud Manufacturing if you are not already logged in.

See Integrate Oracle Fusion Cloud Manufacturing with Oracle IoT Production Monitoring Cloud Service for more information on Oracle Fusion Cloud Manufacturing integration.

Create a Digital Birth Certificate

Use a digital birth certificate to find out about the health of a machine during a certain period in the past. With this report you can identify if a machine was underperforming during the production of a certain product and decide if you want to cancel the shipping of a product, recall it, or grade your products.

To create a digital birth certificate for a specific product, you must have defined a production plan for that product.

1. In the **Map** view, click a factory icon.

   You can also use the breadcrumbs to navigate to a specific factory.

2. Select the **Reports** tab .

3. From the **Product Time From** list, click **Select Date** to select a start date, then click **Select Time** to select a start time.

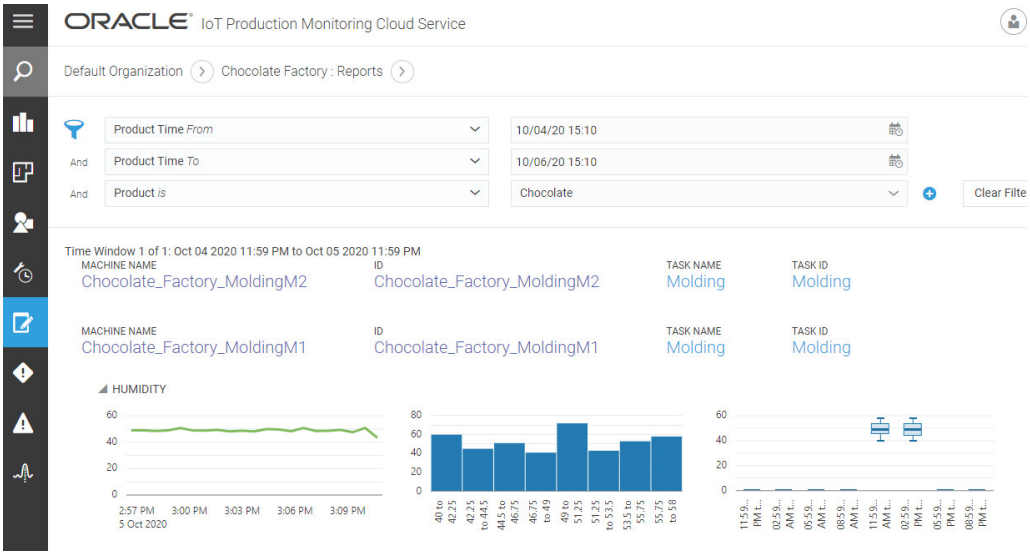
4. From the **Product Time To** list, click **Select Date** to select a end date, then click **Select Time** to select an end time.

5. From the **Product is** list, select the product to use in the digital birth certificate.

6. (Optional) Click **Add** to add additional filter parameters.

   You can add search parameters to include an additional product, another production period, or a specific production line.

The report includes the number of products, the machines involved in the production, and the distribution and statistics of the sensor attributes during the specified period.

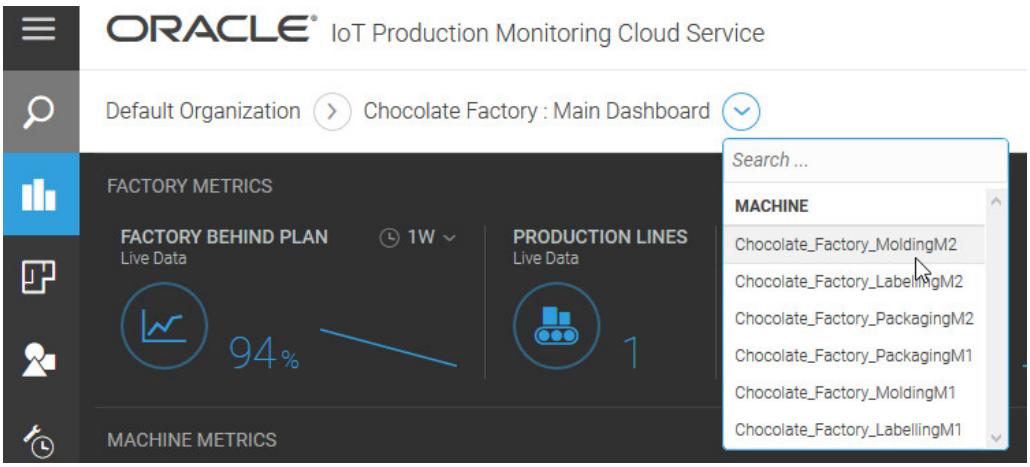


If the production corresponds to an Oracle Fusion Cloud Manufacturing work order, then the work order ID also appears against each production routing task. If the routing task includes an operator, then the operator user name also appears against the task.

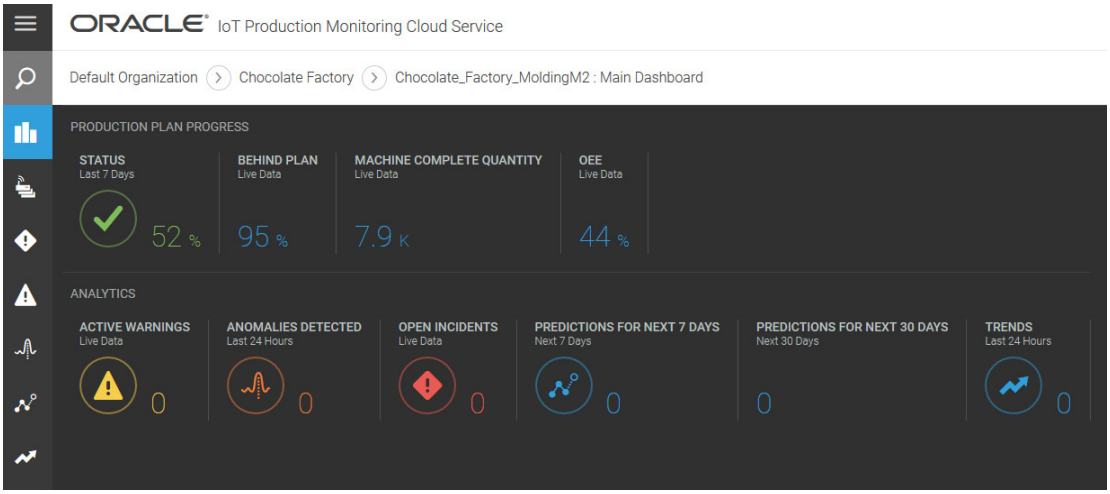
Monitor a Specific Machine

For each of your machines, you can view the machine metrics on the main dashboard. You can also look at sensor data, incidents, warnings, predictions, anomalies, and trends for the machine.

In the Operations Center factory view, use the breadcrumbs to navigate to a specific machine in the factory. You can also click the machine in the factory **Floor Plan** view or the **Production** view.



The main dashboard for the machine appears by default. The dashboard shows the real-time and historic performance data for the machine.



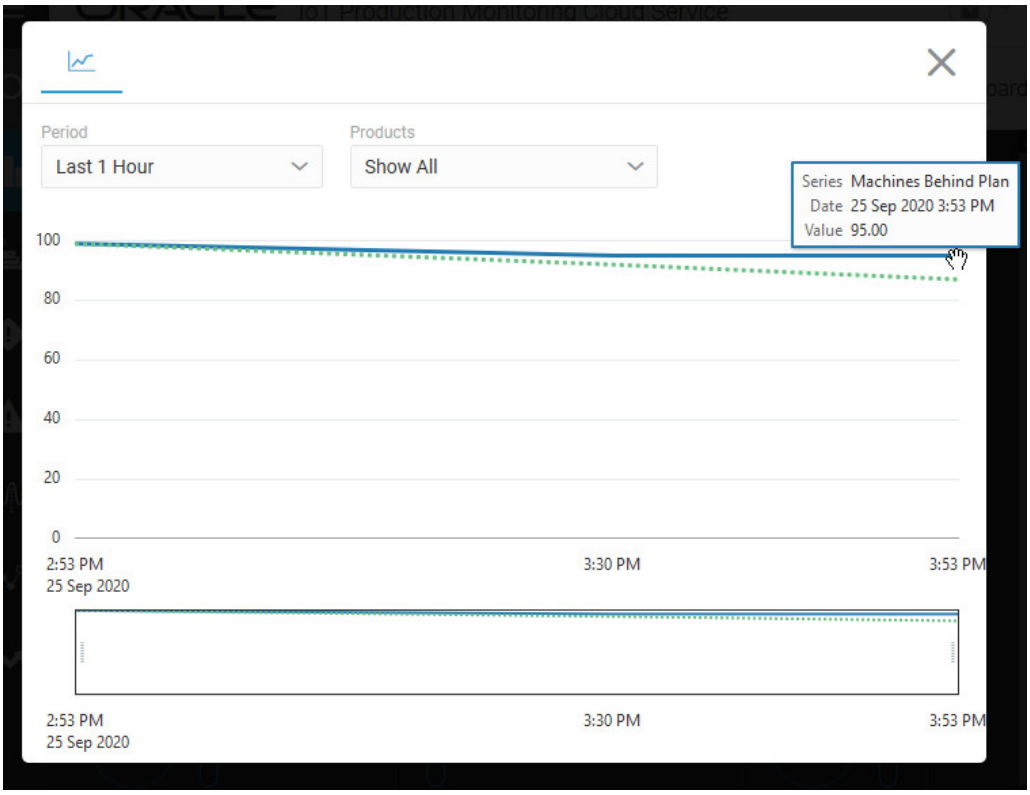
The ready-to-use dashboard includes common machine metrics. The following table describes the default metrics that appear.

Metric	Description
Behind Plan	The percentage of the production plan that remains to be completed. When production first starts, all machines are 100% behind plan. A machine reaches 0% when all product units assigned to it have been produced. Click the metric to see a chart of **Behind Plan** statistics over time. You can select the desired time **Period**. You can also filter the chart by product if a machine produces multiple product types.
Status	The percentage of time that this machine has been in use during the specified period of time. Click the metric to see the **Status** over time. You can select the desired time **Period**. You can choose to see the percentage of time that the machine was idle or down.
Machine Complete Quantity	Shows the number of product units produced by the machine Click the metric to see a chart of completed units over time. You can select the desired time **Period**. You can also filter the chart by product if a machine produces multiple product types.
OEE	This value specifies the overall equipment effectiveness. Click the metric to see a chart of OEE values over time. The OEE values include the availability, quality, and performance percentages for the machine. You can select the desired time **Period**. You can also filter the chart by product if a machine produces multiple product types.

You can include other system metrics by editing the dashboard for the machine type in Design Center. For example, you can add system metrics for the number of scrap or reject product quantities produced by the machine. You can also add custom metrics to the dashboard.

> **Note:**
>
> You can create additional custom dashboards for a machine type in Design Center.

Click a metric to open its corresponding chart. You can choose predefined or custom time periods for your charts. If a machine manufactures more than one product, you can also filter the chart by product. The following chart shows the **Behind Plan** percentage and compares it with the best machine in the factory.



> **Note:**
>
> When selecting time periods for your sensor and metric charts, the values available depend on the data life spans for your sensor and metric data. You can view data up to a maximum of six months if the storage life span for your sensor and metric data exceeds six months.

Close the chart window to return to the main dashboard.

The main dashboard also shows the count of active warnings and open incidents for the machine. If you have configured anomalies for the machine, then any detected anomaly count is displayed. If you have configured predictions and trends, then the existing prediction and trend count is displayed.

Click an item to see more details on it. For example, click the trend count to go to the Trends page.

In addition to the main dashboard, there are several tabs, or views, available for your factory. The following table summarizes these tabs.

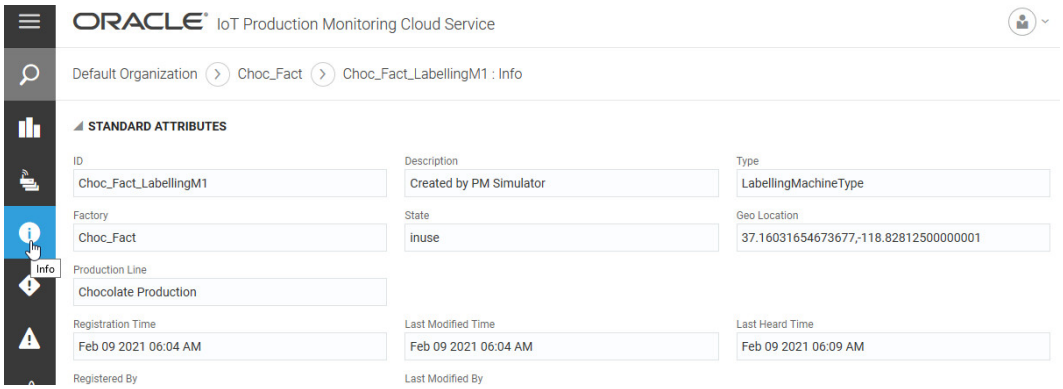
Tab Name	Icon	Description
Main Dashboard		View the machine metrics at a glance. Click a metric to see details. You can customize the factory dashboard in the Design Center to add or remove metrics.
Sensors		View sensor data and charts for the sensors associated with the machine.
Info		View the standard machine attribute values, such as registration time-stamp and production line name, at a glance. You can also view the custom attribute values.
Incidents		View the incidents report for this machine. You can filter the list of incidents by specifying one or more search parameters.
Warnings		View the warnings report for this factory. You can filter the list of warnings by specifying one or more search parameters.
Anomalies		View the anomalies report for the machine.
Predictions		View the predictions for the machines.
Trends		View sensor data trends for the machine.
Search		Lets you search for other machines, factories, and locations.

View Machine Info and Sensor Data for a Machine

View the real-time and historic sensor data for a specific machine. You can compare different sensor attribute values to study correlation. You can also analyze the effects of sensor data variations on machine state changes and production quantities.

1. Click the **Info** tab from the machine view.

   In Operations Center, use the breadcrumbs to navigate to a specific machine in the factory. You can also click the machine in the factory **Floor Plan** view or the **Production** view.



The Info page lets you view the standard machine attribute values, such as registration time-stamp and production line name, at a glance. You can also view any custom attribute values that may be present.

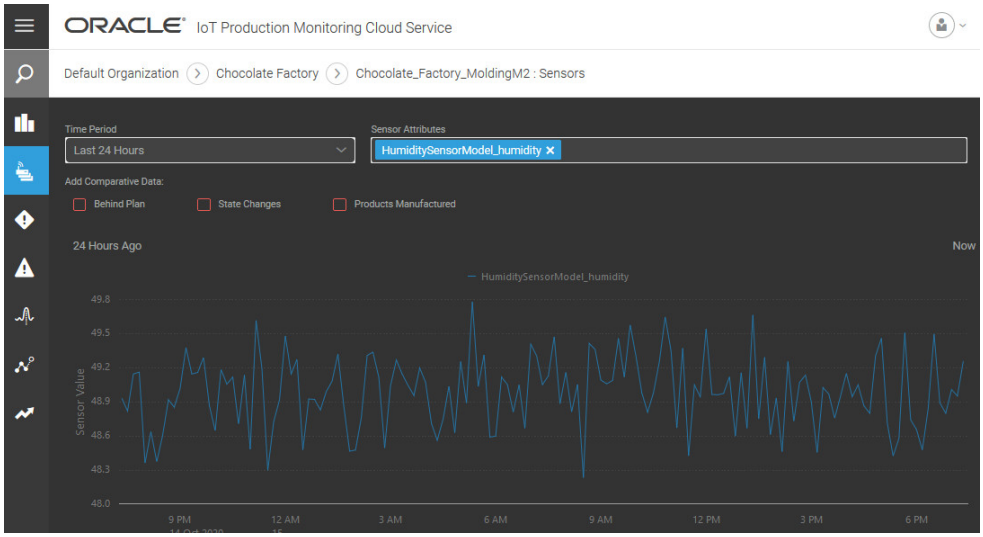
2. To view sensors for the machine, click the **Sensors** tab from the machine view.
3. From the **Time Period** list, select the time period for which you want to view the performance of your machine.

   The following options are available:

   - **Live**
   - **Last 1 Hour**
   - **Last 24 Hours**
   - **Last 7 Days**
   - **Last 30 Days**

> **Note:**
>
> When selecting time periods for your sensor and metric charts, the values available depend on the data life spans for your sensor and metric data. You can view data up to a maximum of six months if the data life span for your sensor and metric data exceeds six months.

4. From the **Sensor Attributes** list, select the sensor attribute name.



You can select more than one attribute if you wish to compare two or more attributes. For example, you may wish to compare the effect of temperature changes on the humidity values.

5. (Optional) Add optional comparative data to study the effects of sensor data variations on machine state changes and production quantities.

   - **Behind Plan**: Superimposes **Behind Plan** system metric data on the sensor chart. Lets you see the effects of sensor data on production.

For example, you may see a flattening of the **Behind Plan** curve with rising engine vibrations. This may indicate that engine performance is affecting the rate of production.

- **Stage Changes**: Superimposes **State Changes** system metric data on the sensor chart. Lets you see the effects of sensor data on machine state.
  For example, you may notice that rising engine temperature is leading to the machine going down.
- **Products Manufactured**: Superimposes **Products Manufactured** system metric data on the sensor chart. Lets you see the effects of sensor data on production.
  For example, you may notice that increased glue viscosity values are leading to a reduction in the number of units produced.

Use Custom Dashboards

In addition to the built-in dashboards available to monitor your organization, factories, and machines, you can also create additional custom dashboards at the organization, factory, or machine-type level.

If you have created user-defined metrics for your environment, you can add these to a dashboard to display the metric values aggregated over all your machines. You can add user-defined metrics to both built-in and custom dashboards.

See Define Your Own Metrics for more information on creating user-defined metrics to track factory and machine data relevant to your business processes.

Create a Dashboard at the Organization Level

When you create a dashboard at the organization level, you can add metrics from across your organizational factories and machines to the dashboard. The dashboard appears in your Operations Center menu bar.

To create a dashboard at the organization level:

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Organization** from the **Design Center** sub-menu.
3. Click **Dashboards**.
4. Click **Create Dashboard** (+).
5. Select **IoT**, and select one of the available templates or layouts.

   You can choose to modify the layout by resizing and repositioning your tiles later, or by adding new tiles.
6. Click **Create**.
7. Select a **Name** and **Icon** for your dashboard.

   Once the dashboard is created, the chosen icon will appear on the Operations Center menu bar.
8. Under **Role Access**, optionally change the user roles to which the content of the dashboard should be available.

   The roles you select can view the dashboard in Operations Center.
9. Proceed to adding metrics to the dashboard.

You can click **Preview** to preview the dashboard at any time. Click **Edit** to go back to editing the dashboard.

10. Click **Save** to save the dashboard.

Create a Dashboard at the Factory Level

When you create a dashboard at the factory level, you can add factory-specific metrics and machine metrics to the dashboard. The dashboard appears in the Operations Center menu bar when you navigate to the factory.

To create a dashboard for a factory:

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Factories** from the **Design Center** sub-menu.
3. Select the correct factory, and click **Dashboards**.
4. Click **Create Dashboard** (+).
5. Select **IoT**, and select one of the available templates or layouts.

   You can choose to modify the layout by resizing and repositioning your tiles later, or by adding new tiles.
6. Click **Create**.
7. Select a **Name** and **Icon** for your dashboard.

   Once the dashboard is created, the chosen icon appears in the Operations Center menu bar when you select the factory in Operations Center.
8. Under **Role Access**, optionally change the user roles to which the content of the dashboard should be available.

   The roles you select can view the dashboard in Operations Center.
9. Proceed to adding factory and machine metrics to the dashboard.

   Machine metrics are aggregated over all machines in the factory.

   You can click **Preview** to preview the dashboard at any time. Click **Edit** to go back to editing the dashboard.
10. Click **Save** to save the dashboard.

Create a Dashboard at the Machine Level

When you create a dashboard at the machine level, you can add metrics relevant to the machine type to the dashboard. The dashboard appears in the Operations Center menu bar when you select a machine of the relevant type.

To create a dashboard for a machine type:

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** sub-menu.
3. Select the correct machine type and click **Dashboards**.
4. Click **Create Dashboard** (+).
5. Select **IoT**, and select one of the available templates or layouts.

You can choose to modify the layout by resizing and repositioning your tiles later, or by adding new tiles.

6. Click **Create**.
7. Select a **Name** and **Icon** for your dashboard.

   Once the dashboard is created, the chosen icon appears in the Operations Center menu bar when you select a machine of the relevant type.
8. Under **Role Access**, optionally change the user roles to which the content of the dashboard should be available.

   The roles you select can view the dashboard in Operations Center.
9. Proceed to adding metrics to the dashboard.

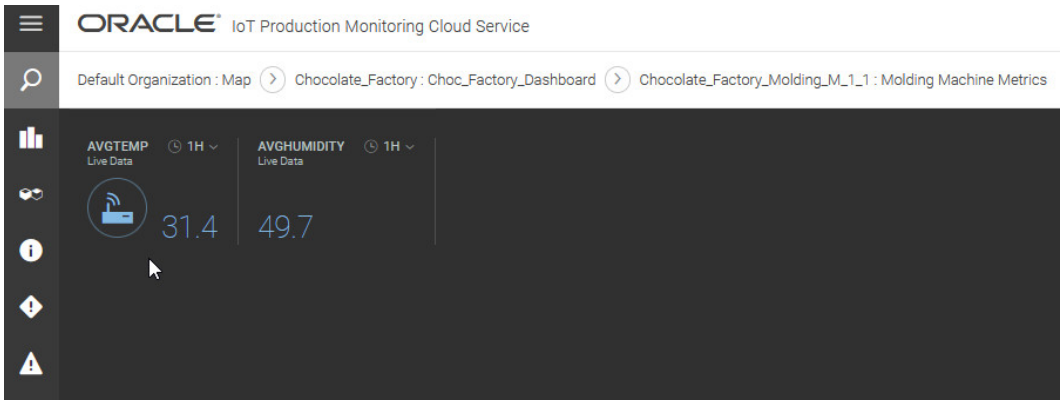
   You can click **Preview** to preview the dashboard at any time. Click **Edit** to go back to editing the dashboard.
10. Click **Save** to save the dashboard.

Visualize and Compare Past Metric Data

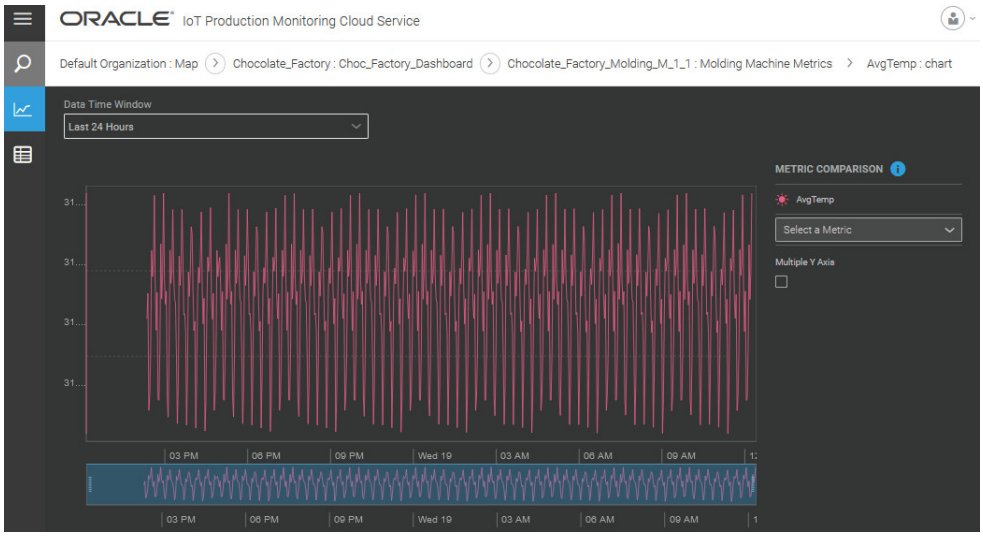
You can view past metric data, in addition to the current metric value, for your dashboard metric gadgets. Choose between the chart view and the tabular view to look at data up to 180 days in the past, depending on your metric storage policies. Past metric data is available for both built-in and custom metrics.

You can also compare up to four metrics in the chart view. For example, you may wish to study possible correlation between two metrics, say *AveragePressure* and *AverageTemperature*. If the metric values are disparate, you can choose multiple y-axes, so that you are able to see each metric plot using the correct scale.

1. In the Operations Center Dashboard view, click the gadget corresponding to the metric.



   The metric chart view appears by default.
2. Select a pre-defined or custom **Data Time Window** value to see the chart for the specified period.

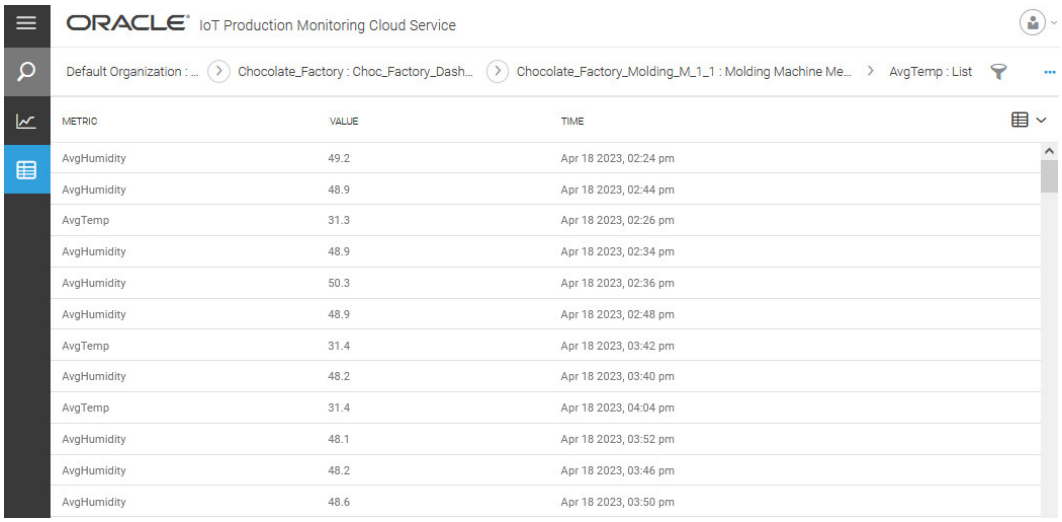


Depending on your metric data storage policies, you can visualize data up to 180 days in the past.

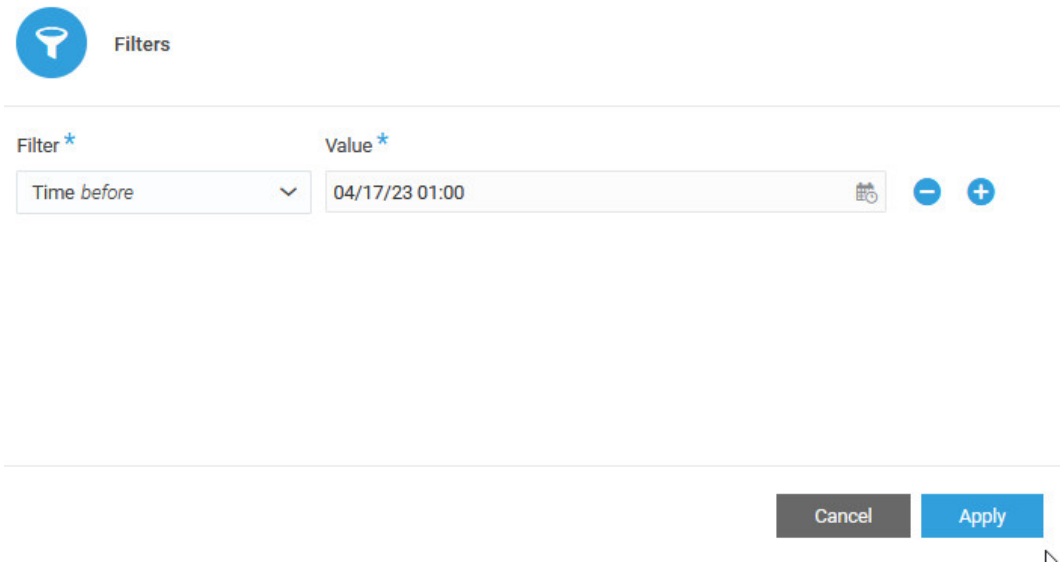
3. Use the **Metric Comparison** area to add metrics to compare.

   You can compare up to four metrics in the chart view. If the metric values are disparate, you can choose multiple y-axes, so that you are able to see each metric plot using the correct scale.

4. Click **List**  in the menu bar on the left to view tabular data for the metric values.



5. (Optional) Choose filters to look at data of interest.



6. Use the breadcrumb navigation link to go back to the dashboard.

6

Diagnose Production Issues

Understand the causes of your production issues and identify the machines that are underperforming.

Topics

- How to Diagnose Production Issues
- Compare Your Factory to Other Factories
- View Historical Values for a Specific Metric
- View the Product Routing
- View and Contextualize Sensor Data for a Specific Machine
- What are Incidents, Warnings, and Alerts?
- View Incidents
- View Warnings
- Define Rules to Trigger Incidents
- Define Rules to Trigger Alerts
- Define Rules to Trigger Warnings

How to Diagnose Production Issues

Identify the factories and machines that are slowing down your production. Start in the map view and drill down to more specific views to isolate the causes of a production incident.

1. Using the **Map** view, compare your factories to locate the factory or factories that are causing your productions issues.

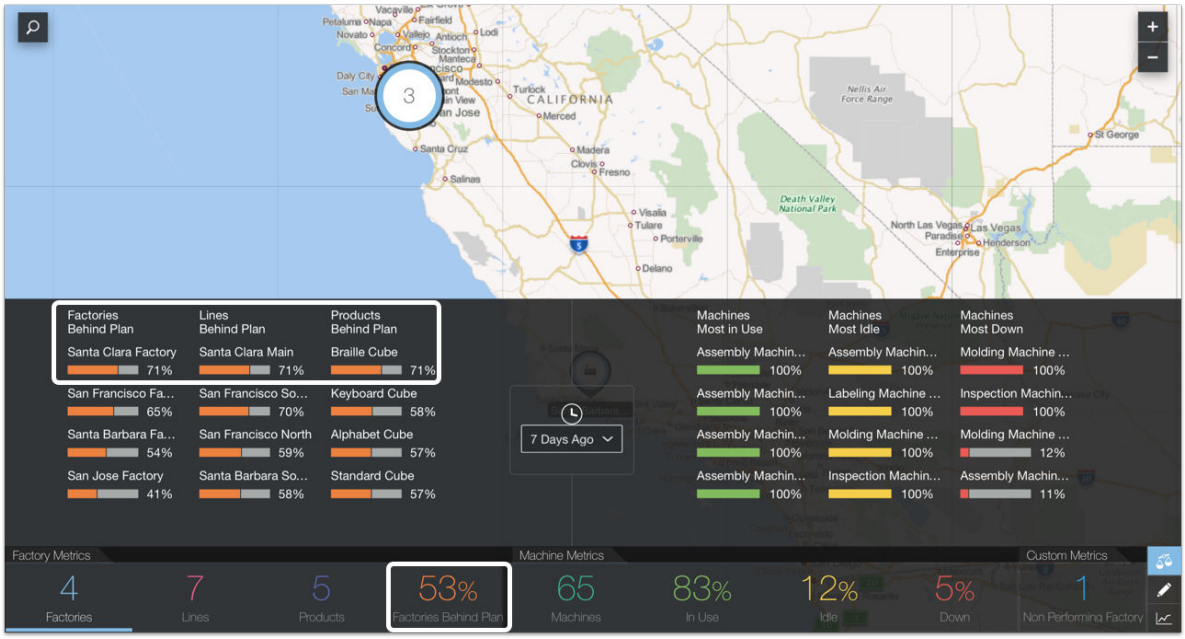
   For information about viewing metrics for a group of factories, see Monitor the Performance for a Group of Factories.

   For information about comparing factories, see Compare Your Factory to Other Factories.

   For example, in this map view 54% of the production is behind plan. If you compare the factories in the map, you can see that the Santa Clara factory is the worst performing factory, 71% of its production is behind plan. Within this factory, the Santa Clara Main production line, and the Braille Cube are the worst performers.

   Diagnosing and fixing the production issues in the Santa Clara factory should improve the overall statistics for your factories.

   This image shows the comparison between the factories and highlights the percentage of factories behind plan (53%) and the worst performing factory (Santa Clara, 71%), production line (Santa Clara Main, 71%), and product (Braille Cube, 71%):

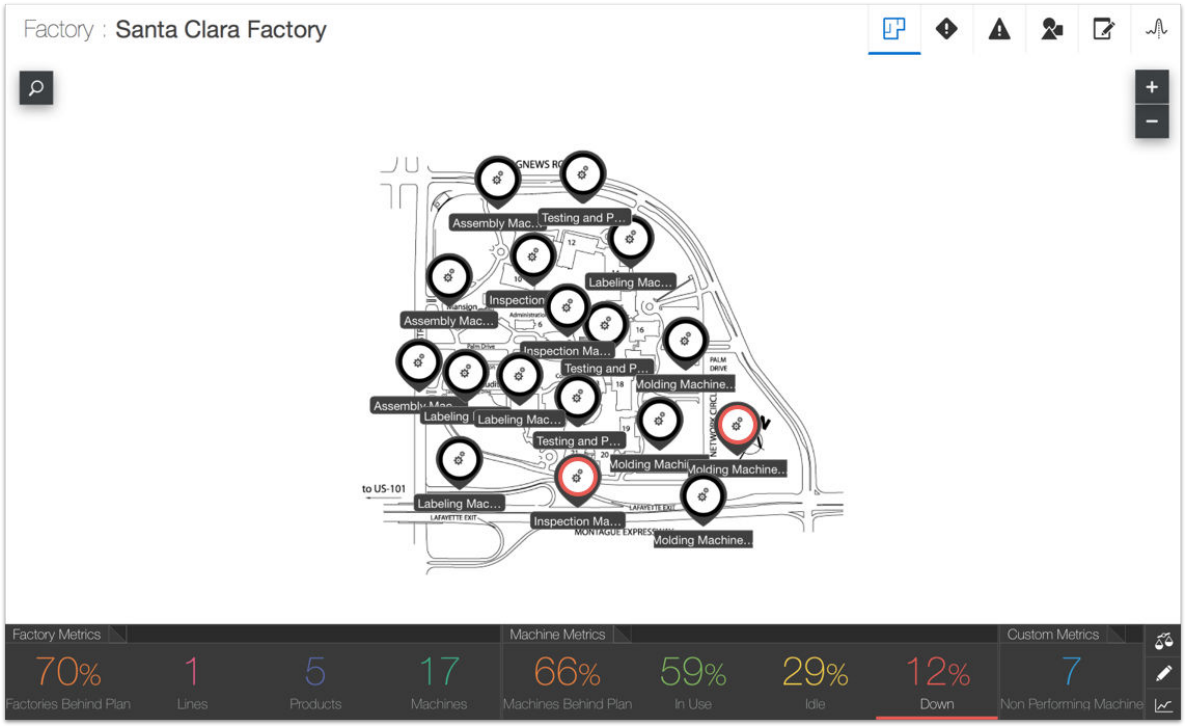


2. Click the factory that has the production issue to view the metrics for that individual factory.

   For information on how to view metrics for a specific factory, see Monitor the Performance of a Specific Factory.

   In our example, expand the Bay Area cluster and click the Santa Clara factory. The Floor Plan view shows that 12% of the machines are unavailable. When you click the **Down** metric, there are only two machines that are unavailable.

   This image shows the floor plan map of the Santa Clara factory. You can see that there's a molding machine and an inspection machine that are unavailable.

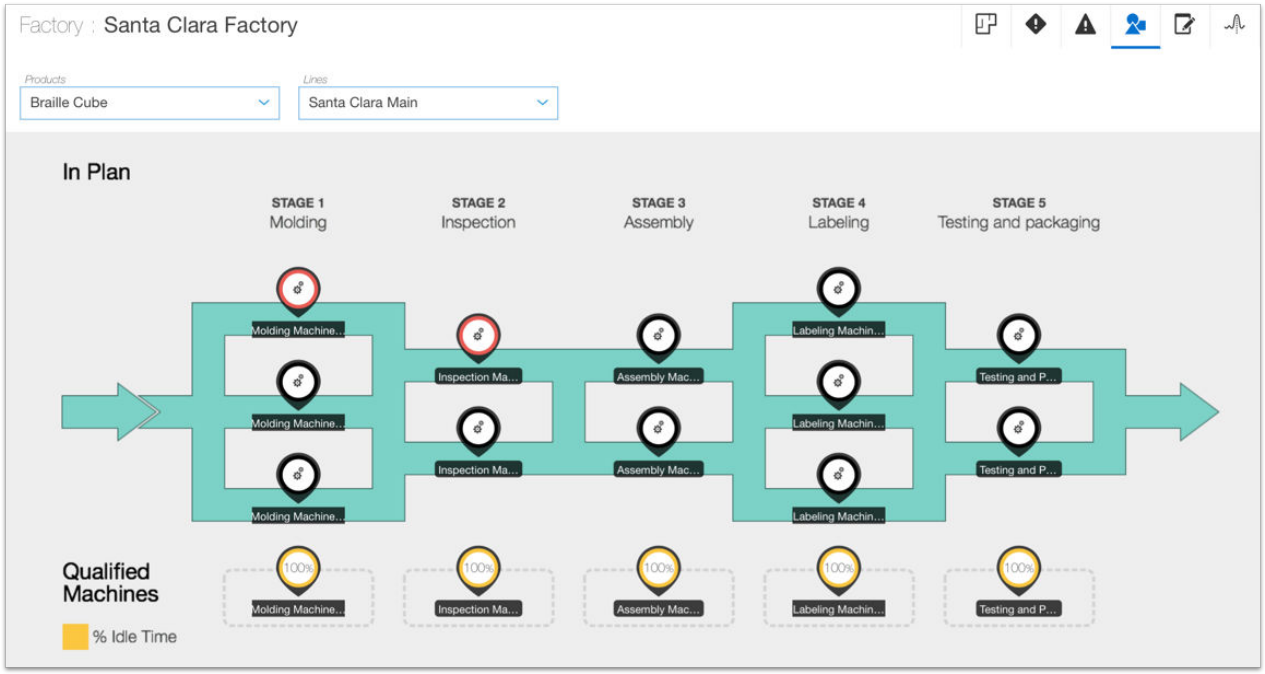


3. Select the **Production** tab to identify the machines that may be causing a bottleneck and slowing down the whole production process.

   For information on the product routing diagram, see View the Product Routing.

   In our example, we know from the comparative view that the production line that is not performing is the main line and that it's specifically having issues with the Braille Cube.

   In the product routing diagram for Braille Cube and the main line, we can see that the molding machine in stage 1 and the inspection machine in stage 2 are unavailable. This is a bottleneck and fixing it might help improve the overall performance of this factory.



4. Check the **Qualified Machines** section to identify machines that can replace the unavailable ones.

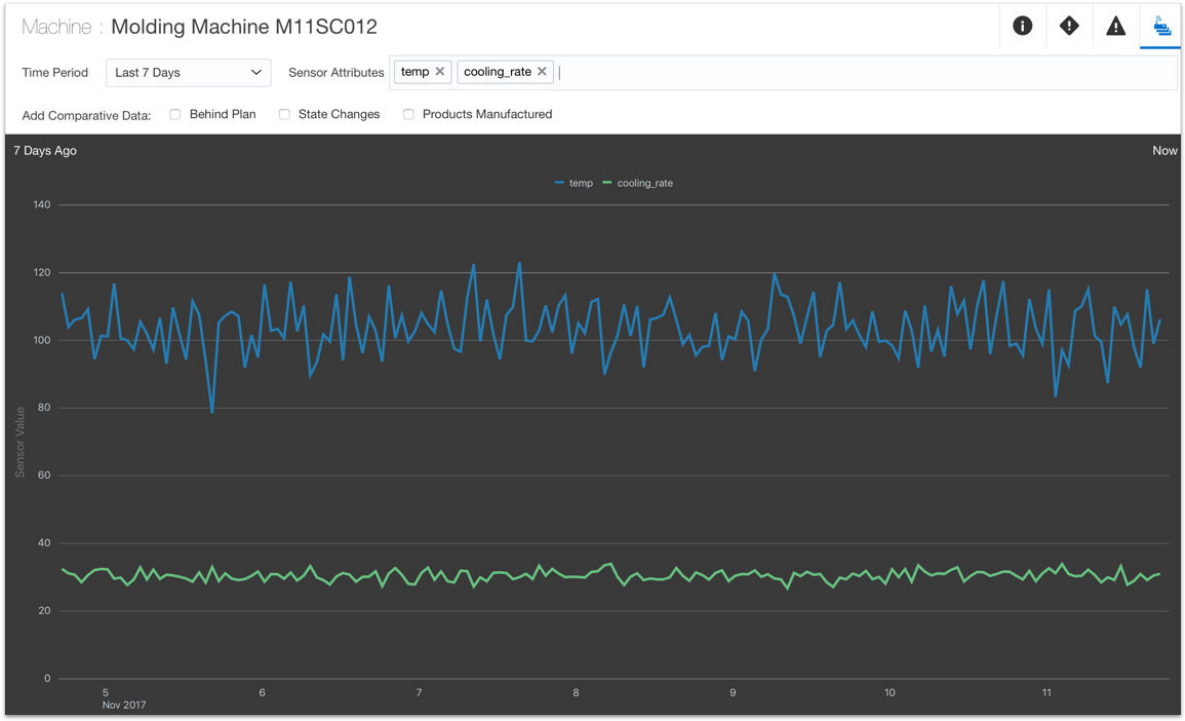
   In our example there is a molding machine and an inspection machine available. We can check with the technician responsible for those machines to use them for production.

5. Use the sensor data of the machines causing the production issue to diagnose the root cause of the problem.

   For information on viewing sensor data, see View and Contextualize Sensor Data for a Specific Machine and View the Sensor Data in the Mobile App.

   In our example, the sensor data for the M11SC012 machine shows that the temperature varies between 40 F and 200F. This indicates the machine is very unstable. The cooling rate also varies between 15 F and 45 F which indicates an abnormal behavior.

   The maintenance technician can use this information to repair the machine. They can access this information from the mobile app while they are repairing the machine on the field.



6. Review the incidents and warnings for that machine.

   The incidents and warnings might help you understand why a machine became unavailable. You can also identify which values you must monitor to identify a machine that it's going to break down.

   For more information on viewing incidents, see View Incidents.

   For more information on viewing warnings, see View Warnings.

After you identify the production issue, you can use the information you gathered to define rules that trigger incidents and warnings before the production issue appears. The rules monitor certain metrics and when the conditions associated with a production issue appear again they trigger a warning or an incident. For information on incidents and warnings, see What are Incidents, Warnings, and Alerts?.

Compare Your Factory to Other Factories

Compare the performance of your factory with other factories using the Map view, or with the best and worst performing factories using the Factory view. This comparison lets you understand how your factory is performing and helps you establish objectives for improving the performance.

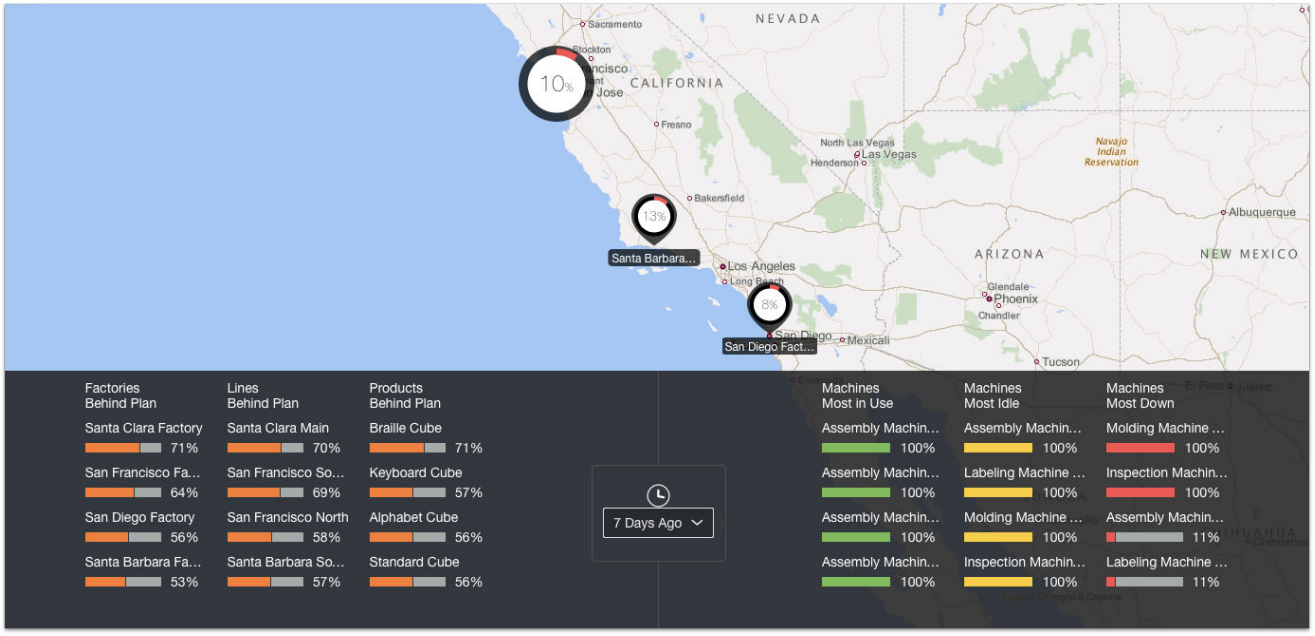
- In the **Map** view:
- Zoom in or out until all the factories that you want to compare appear in the map, then click **Compare** located in the **Metrics** toolbar.
- You can use the default time period, or select a different period from the **Time** list .
- Compare the following metrics:

  - Factories behind plan: the percentage of planned production output that was not fulfilled for each of the compared factories.
  - Lines behind plan: the lines with the higher percentage of planned production output that wasn't fulfilled.
  - Products behind plan: the percentage of planned production that wasn't fulfilled displayed by product.
  - Machines in use: the machines with the highest usage percentage.
  - Idle machines: the machines with the highest idle percentage.
  - Down machines: the machines with the highest percentage of unavailability.

- In the **Factory** view:
- Select the **Floor Plan** tab or the **Production** tab, and then click **Compare** located in the **Metrics** toolbar.
- You can use the default time period, or select a different period from the **Time** list.

  A section showing how your factory compares to the best and worst performing factory appears. This comparison is based on the percentage of planned production output that wasn't fulfilled. This section also shows the machines with the highest percentages of usage, idle time, and down time.

The following image shows a comparison for the last week for all the factories that appear in the map. You can compare the percentage of production behind plan, the percentage of lines behind plan, and the percentage of production behind plan for each product. You can also view the machines that have the greatest percentage of use, idle time, and down time.



View Historical Values for a Specific Metric

View the historical values for a specific metric to better understand the current performance of your factories. The graphic also lets you compare the historical values against the values of the best performing factory.

1. In the **Map** view or in the **Factory** view, select a metric, then click **History** .

   A graphic showing the historical values for the selected metric appears. The graphic also contains the historical values for the best performing factory.

2. Select the period of time for which you want to view the historical values.

   The default value is **7 Days Ago**. You can change this value to show the last day, or the last two or three weeks.

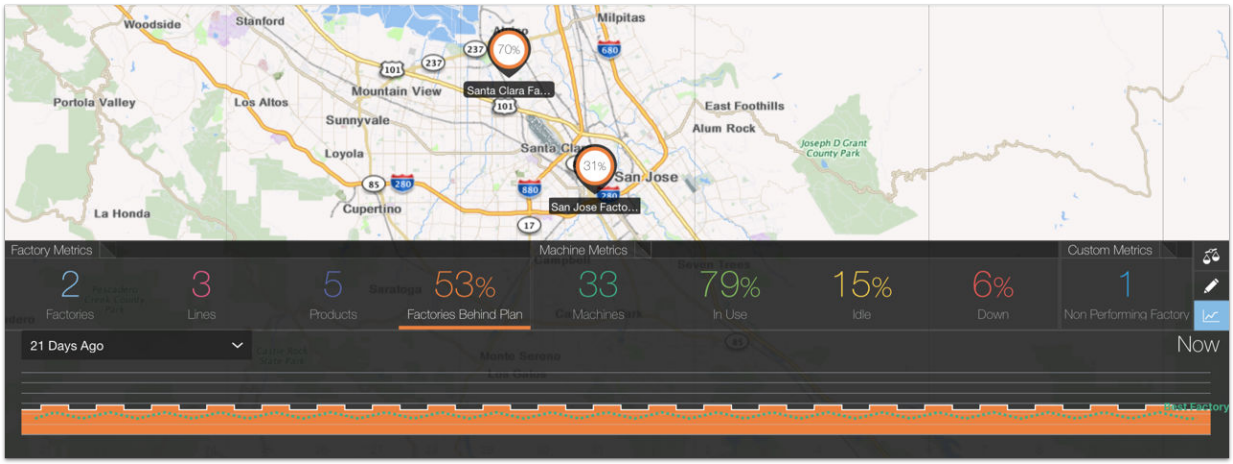
3. (Conditional) In the factory view you can select one or more options of comparative data.

   Comparative data helps you understand the values in the graphic. For example, if you're looking at the history for the percentage of machines behind plan, you might want to compare it with the history of unavailable (Down) machines to understand if this is what's causing them to fall behind schedule.

   You can compare your values with the following metrics:

   - Behind Plan
   - In Use
   - Idle
   - Down

The following image shows the historical values for the percentage of factories behind plan for the last three weeks for the Santa Clara and San Jose Factory. The green dotted line lets you compare the performance of your factories with the best performing factory.



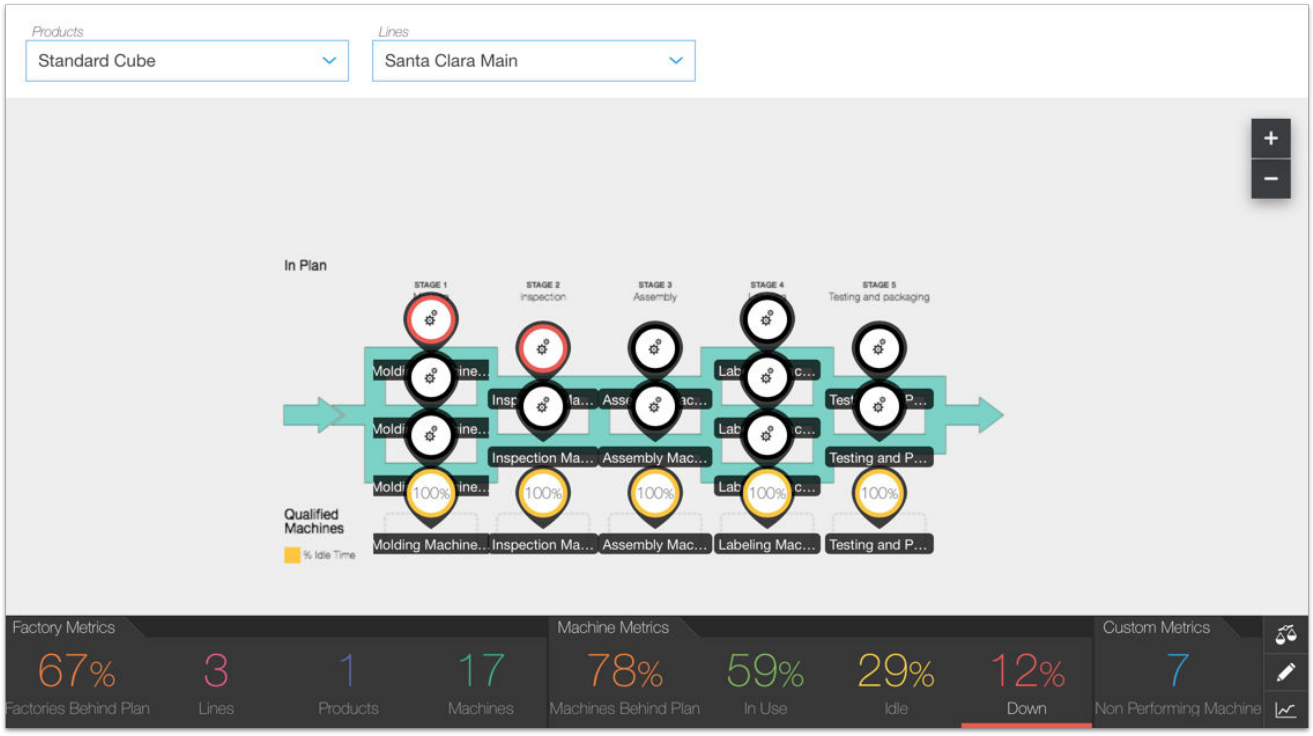
View the Product Routing

View the route a certain product follows in a certain product line. You can view the different stages of the production process and the machines allocated for the manufacturing of this product. This diagram helps you identify bottleneck in your production process.

In the **Factory** view, select the **Production** tab . Then select a product and a production line.

You can also view factory and machine metrics in the product routing diagram, see Monitor the Performance of a Specific Factory.

This image shows the product routing for the Santa Clara Main production line for the product Standard Cube. The **Down** metric is selected, so the factories that are unavailable are highlighted in red.



View and Contextualize Sensor Data for a Specific Machine

Analyze the sensor data to identify the cause the production issues in a specific machine. You can also compare the sensor data to other data to understand the values gathered by that sensor.

1. In the **Factory** view, select the **Floor Plan** or **Production** tab, then select a metric, and then click **Sensors** .

   The graphic will remain empty until you select a sensor attribute.

2. From the **Time Period** list, select the the period of time that you want to monitor.

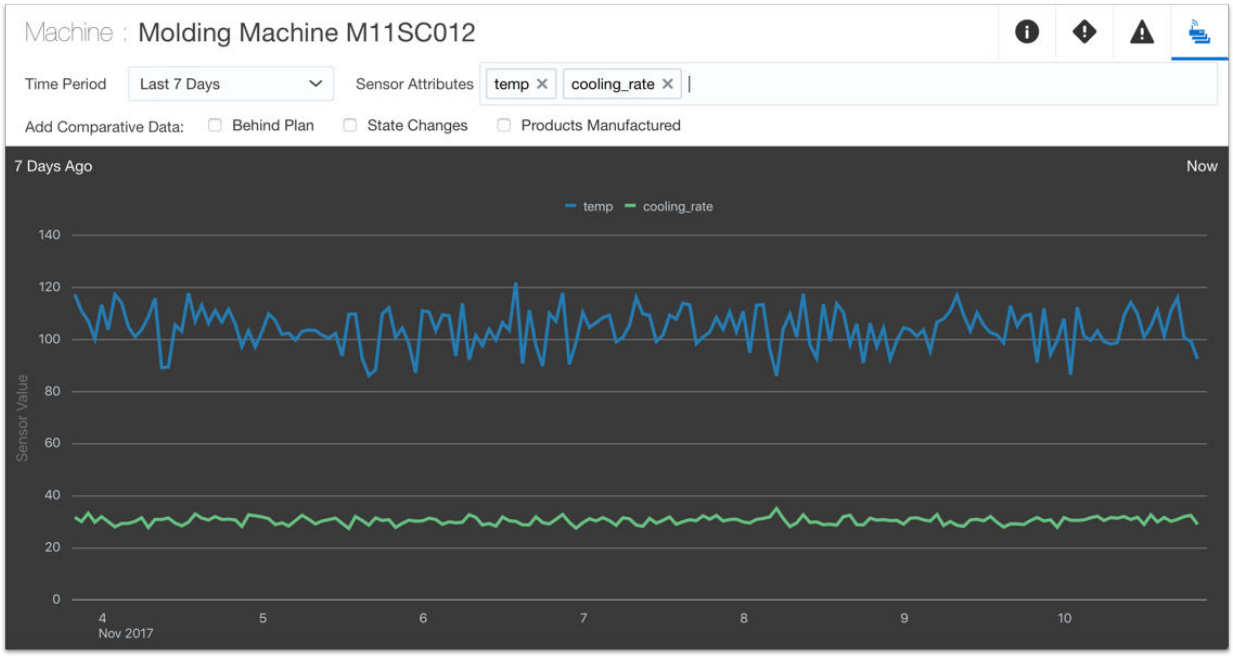
   You can view live data, or the historical data for the last day, the last week, or the last month.

3. From the **Sensor Attributes** list, select one or more sensor attributes to monitor.

4. From **Add Comparative Data** select one or more options to contextualize the sensor data:

   - Behind Plan
   - State Changes
   - Products Manufactured

The following image shows a graphic of the temperature and cooling rate values for the sensors in the Molding Machine M11SC012 for the last week. You can use these values to understand why this machine is currently unavailable.



What are Incidents, Warnings, and Alerts?

Monitor incidents, warnings, and alerts to learn about issues that might delay or interrupt your production process. Define rules to trigger these events based on the nature of the production issues and the actions required to resolve them.

Monitor the list of incidents to learn about those production issues that require a maintenance technician to repair or tune a machine to get resolved. Incidents have a priority and a status that you can use to manage and track the resolution of the production issue. You can view incidents from the web application and from the mobile application. See View Incidents and View and Update Incidents in the Mobile App.

View the list of warnings to diagnose production issues or to learn details about the performance of your factories and machines. Warnings do not require a human to resolve them, they get resolved once the value you are monitoring goes back to

normal. Typically warnings get resolved on their own, multiple warnings for the same issue or a warning that's been active for a long time might indicate a problem with the affected machines. See View Warnings.

Alerts do not appear in the user interface because they are used to integrate with other business systems, or from REST clients. The way you view and monitor alerts depends on the business system integration or REST client you are using.

When to Create an Incident?

Define rules to create incidents for issues that need human interaction to get resolved. Incidents provide a structured life cycle that you can use to track the status and resolution of the production issue. Incidents also appear in the mobile application so that maintenance technicians can access and update the incident while they are working on the field.

For example, if a machine breaks down, you can create an incident to inform the maintenance technicians that the machine needs to be repaired. This incident also allows you to track the status of the service request.

For information on how to create incidents, see Define Rules to Trigger Incidents.

When to Create a Warning?

Define rules to create warnings for temporary issues that might resolve on their own. Warnings let you keep track of these issues so that you can use them to asses the status of a machine, or to diagnose a production issue.

For example, you can create a warning when the temperature goes above 70 F. If the temperature goes back to normal in the next reading, the warning will get automatically resolved.

For information on how to create warnings, see Define Rules to Trigger Warnings.

When to Create an Alert?

Define rules to create alerts for issues that require you to trigger actions in another system or in a REST API client.

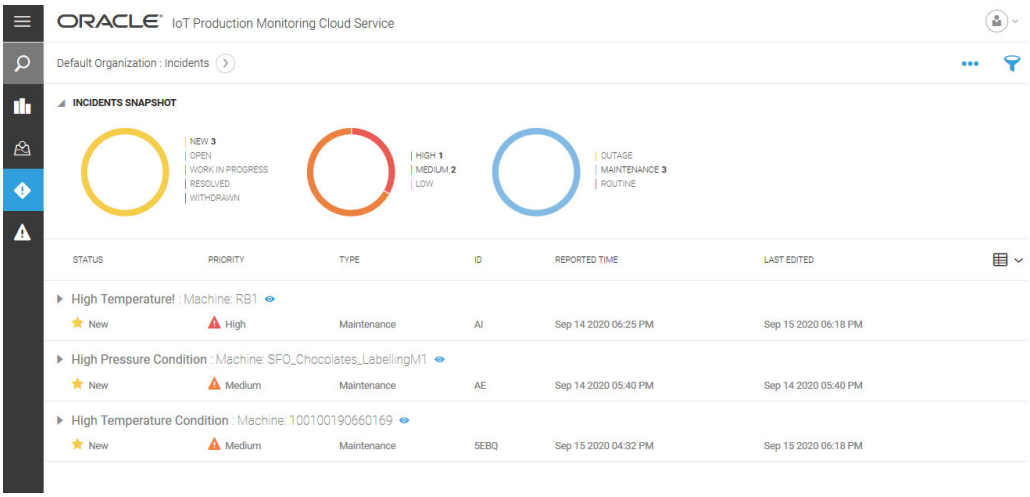
Alerts do not appear in the Oracle IoT Production Monitoring Cloud Service user interface. You can access alerts using REST APIs or the Oracle Internet of Things Intelligent Applications Cloud **Management Console.**

View Incidents

View the list of incidents for your organization, factory, or machine. Managers can view general statistics that provide a clear picture of the health of their factories and the current amount of maintenance work. Maintenance technicians can view the list of work and update the status of the incidents.

View and manage incidents from the Incidents page. You can also change the status of an incident from this page.

To open the Incidents page, click **Incidents**  in the Operations Center menu bar. The incidents applicable for your current context appear. You can change your context from the breadcrumbs to navigate to a particular factory or machine.



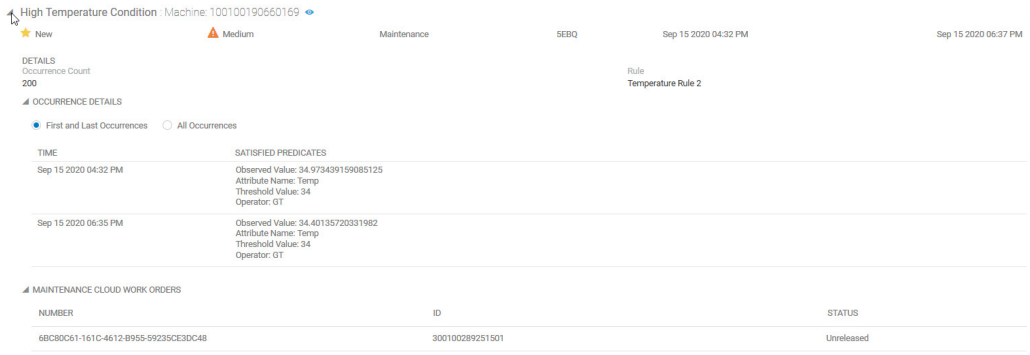
The pie charts under the **Incidents Snapshot** section categorize the incidents by status, priority, and category. You can click the arc segments to quickly filter the list of incidents. Click the center of the circle to remove a filter.

You can select the incident columns that you wish to see, and remove the ones that you do not need. Click **Show/Hide Columns** to select or deselect column headings.

Clicking **View** against an incident takes you to the main dashboard for the machine, by default.

See Details of an Incident

Expand an incident by clicking the arrow icon next to it. The incident details include occurrence details, name of the rule that created the incident, and other details, such as sensor and metric values used as predicates in the rule.



If your machine has a corresponding asset in Oracle Fusion Cloud Maintenance, then the details of the maintenance work order created for the incident are also shown. The details include the work order number, ID, and current status of the work order in Oracle Fusion Cloud Maintenance.

Search for Incidents Using Filters

Filter your incident list by priority, reported date, edited date, status, type, source, and summary. Click **Filter** and select your filter criteria from the options that appear. You can add multiple conditions or criteria.

Sort an Incident List

Sort an incident list to view incidents by priority, reported time, status, type, or summary. Click the **Up** icon or the **Down** icon against a column header to sort by the column name, and to toggle between ascending and descending orders.

Edit an Incident

Click **Edit** against an incident row to update the incident status, withdraw the incident, or to add comments. You can also edit the incident details such as the summary and the description, and view details such as the factory and machine where the incident occurred.

Export Incident Data

Export the incident data to a comma separated (CSV) file. You can use this file to view the list of incidents in a spreadsheet editor, or to import the incidents to other applications that accept this format. Click the **Incident Menu** and select **Export**.

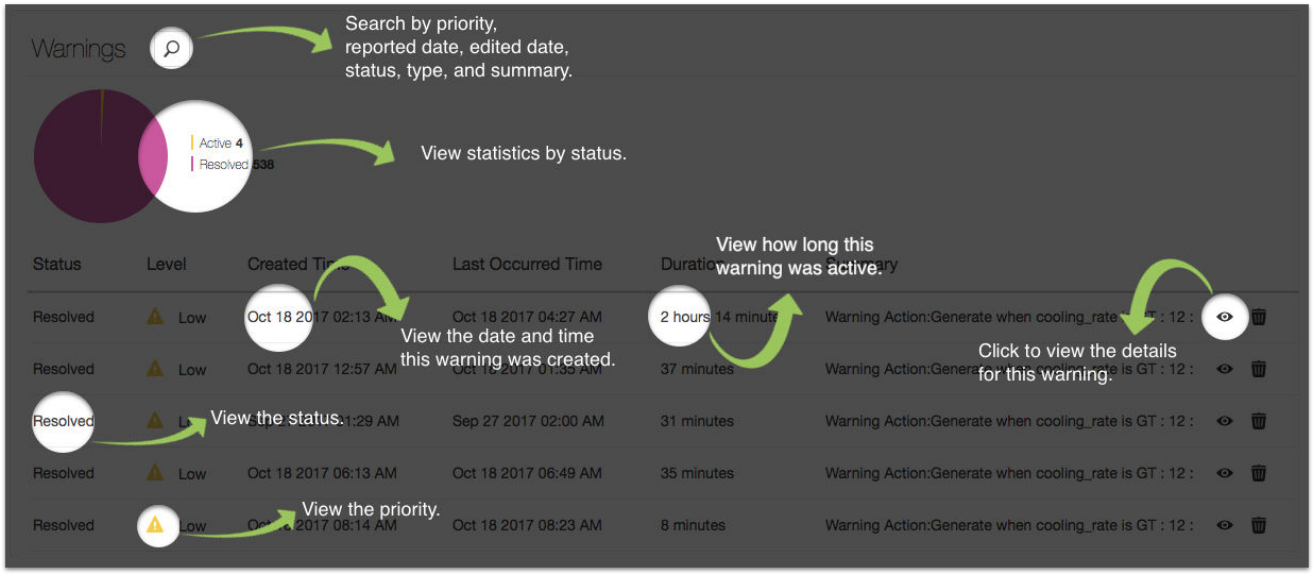
Print Incident Data

You can choose to print the incident data. Click the **Incident Menu** and select **Print**.

View Warnings

Monitor the warnings for your factory to decide if you need to act on them based on their progress.

This image shows the different available actions in the **Warnings** view.



Search

Filter your warning list by priority, reported date, edited date, status, type, and summary.

View Statistics

View a pie chart diagram of the total warnings grouped by status.

View Details

View the status, level, duration, summary, and dates when the warning was created and occurred for the last time.

Click **View** to view more details such as the factory and machine where this warning occurred, or the number of times it occurred.

View Warnings for a Specific Factory

In the **Factory** view, click **Warnings** to view the list of warnings for this specific factory. You can filter this list by level, date it was created, last time it occurred, status, and summary.

View Warnings for a Specific Machine

In the **Machine** view, click **Warnings** to view the list of warnings for this specific factory. You can filter this list by level, date it was created, last time it occurred, status, and summary..

Use SMS, Email, and HTTP Notifications

Oracle IoT Production Monitoring Cloud Service integrates with the Twilio SMS service to help provide seamless SMS notifications. You can also use the default SMTP account, or your own SMTP server, for sending out email notifications. HTTP endpoint notifications are also supported for external applications.

You can configure Oracle IoT Production Monitoring Cloud Service to send SMS notifications for incidents, warnings, and alerts. When an associated rule triggers an incident, warning, or alert, SMS notifications are sent out to all configured subscribers on their mobile devices.

You can also send email notifications for incidents, warnings, and alerts. When an associated rule triggers an incident, warning, or alert, email notifications are sent to all configured subscribers. The email notifications also contain a link to the corresponding incident making it easy to navigate to the incident details in the application.

HTTP endpoint notifications are also supported for external applications. For example, an application, such as Oracle Transportation Management (OTM) or Oracle Intelligent Track and Trace can receive alerts and incident notifications from the connected IoT application.

SMS, email, and HTTP notifications eliminate the need to monitor the Oracle IoT Production Monitoring Cloud Service application continuously. All subscribers are actively informed about the incidents, warnings, or alerts that need attention. You can

then use the Oracle IoT Production Monitoring Cloud Service mobile application or Web interface to look at, and address, the issues.

To use the SMS notification service, you must have a Twilio account subscription. Add your Twilio account information to Oracle IoT Production Monitoring Cloud Service to start using the notification service. After adding your account, you can add subscribers that need to receive these notifications, and select the rules that should send the notifications.

To use email notifications, you can use the built-in, default SMTP account. The default account has a usage limit of 100,000 messages. Alternatively, you can use your own SMTP server to channel Oracle IoT Production Monitoring Cloud Service email notifications. After choosing your SMTP account, you can add subscribers that need to receive these notifications, and select the rules that should send the notifications.

Add Your SMS Notification Account Details

To start using the notification feature, add your notification account details in Oracle IoT Production Monitoring Cloud Service. For SMS notifications, add your Twilio account details.

Make sure that the IoT administrator has already added the Twilio domain as a trusted CN in the Oracle Internet of Things Intelligent Applications Cloud management console. To do this, the administrator adds `*.twilio.com` under **Trusted CN** in the Settings page.

To add the notification account details in Oracle IoT Production Monitoring Cloud Service:

1. In the Operations Center, click **Menu** (), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **Notification Accounts**.
3. Click **Create Notification Account** ().
4. Select your **Provider**.

   Oracle integrates with Twilio, as the third-party notification service provider.
5. Enter a **Name** for your notification account.

   For example, *My Twilio Account.*
6. Enter the **SID** for your Twilio account.

   This is your Twilio account SID that you can get from your Twilio console.
7. Enter the **Authorization Token** associated with your Twilio account.

   You can get the authorization token from your Twilio console.
8. Enter the **Sender Phone No** for notification messages.

   The sender phone number is provided by Twilio, and can be generated in your Twilio account.
9. Click **Create** to add the notification account.

You can next add subscribers or recipients for the SMS notifications.

Add Your Email Notification Account Details

To start using the email notification feature, you can use the built-in, default SMTP service in Oracle IoT Production Monitoring Cloud Service. Alternatively, you can add your own SMTP server to send unlimited email notifications.

The default SMTP service in Oracle IoT Production Monitoring Cloud Service lets you send limited email notifications. The usage limit is 100,000 messages per cycle. If your usage needs are different, you can add your own SMTP notification account.

Make sure that the IoT administrator has already added the SMTP domain as a trusted CN in the Oracle Internet of Things Intelligent Applications Cloud management console. To do this, the administrator adds `*.yourSMTPdomain.com` under **Trusted CN** in the Settings page.

To add the SMTP notification account details in Oracle IoT Production Monitoring Cloud Service:

1. In the Operations Center, click **Menu** (), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **Notification Accounts**.

   Notice that the Notification Accounts section already includes the default SMTP account.
3. To add your own SMTP account, click **Create Notification Account** ().
4. Under **Provider**, select **SMTP**.
5. Enter a **Name** for your notification account.

   For example, `My SMTP Account`.
6. Enter the **User Name** and **Password** for your SMTP account.
7. Enter the **SMTP Host** server name.
8. Enter the **SMTP Port**.

   The default port number is 465.
9. Under **From**, enter the sender email ID to be used for sending email notifications.
10. Optionally select **Use TLS** (Transport Layer Security) to secure SMTP with an encryption protocol.
11. Click **Create** to create the notification account.

You can next add subscribers or recipients for the email notifications.

Add Your HTTP Notification Account Details

To start using the notification feature, add your notification account details in Oracle IoT Production Monitoring Cloud Service. For HTTP notifications, add your external application HTTP endpoint URL.

To add the notification account details in Oracle IoT Production Monitoring Cloud Service:

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **Notification Accounts**.
3. Click **Create Notification Account** (+).
4. Under **Provider**, select **HTTP**.
5. Enter a **Name** for your notification account.

   For example, *External HTTP Account.*
6. Enter the endpoint **URL** for your external HTTP application.
7. Select the **Authentication Type**.

   The password-based **Basic** authentication type is currently supported for HTTP notifications.
8. Enter the **User Name** and **Password** credentials for your external HTTP endpoint.
9. Click **Create** to add the notification account.

You can next add subscribers or recipients for the HTTP notifications.

Add Subscribers for the Notifications

You can add one or more subscribers for a notification. You can also create different subscriber groups and add them to rules, as desired.

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.
2. Click **IoT Organizations**.
3. Click the name of your organization.
4. Click **Subscribers** to open the subscribers page for your organization.
5. Click **Create Subscriber** () to add a new subscriber or group or subscribers.
6. Select your **Notification Account**.

   See Add Your SMS Notification Account Details, Add Your Email Notification Account Details, and Add Your HTTP Notification Account Details for more information on adding SMS, email, and HTTP notification accounts.
7. Enter a **Name** for the subscriber or group of subscribers that you are creating.

   For example, *Production Team*.
   You may want to create different subscriber groups based on the factories or machines managed by each group.
8. (Optional) Select pre-existing **Rules** to subscribe to events from the selected rules.

   Note that you can also add notification subscribers to an individual rule by editing the rule, or when creating a new rule.
9. For SMS and email notification accounts, select the **Contact Method**.
   - **Subscribers:** Select to add existing user names as subscribers.

- **Emails:** For email notification accounts, select to add subscribers using their email addresses.
- **Phone Numbers:** For SMS notification accounts, select to add subscribers using their phone numbers.
- **Subscribers and Emails:** For email notification accounts, select if you wish to add some subscribers using their user names and others using their email addresses.
- **Subscribers and Phone Numbers:** For SMS notification accounts, select if you wish to add some subscribers using their user names and others using their phone numbers.

a. If you chose **Subscribers**, select existing users to add them as subscribers.

   Depending on whether you have chosen an SMS or email notification account, the phone numbers or emails of the users are added to the subscriber group.

b. If you are configuring an SMS subscriber group, you can individually enter the subscriber **Phone Numbers**.

   Precede the phone numbers with the country codes. Press enter after entering each phone number.

c. If you are configuring an email subscriber group, you can individually enter the subscriber **Emails**.

   Press enter after entering each email address.

10. Click **Create** to finish creating the subscriber group.

Use Machine Alerts

You can define alert attributes for your machine type if your sensor device supports alerts. For example, a mechanical robot sensor may support a robot-arm-jammed alert.

Define alert attributes for your machine type and associate these with the corresponding device alerts for your machines. You can then use the alerts in your rule conditions to take necessary action. For example, you can generate an incident if a machine raises a high temperature alert.

Define an Alert for a Machine Type

Define an alert for a machine type to associate device alerts with their corresponding machines in Oracle IoT Production Monitoring Cloud Service.

1. Click **Menu** ☰ and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** menu.
3. Select your machine type from the list of existing machine types.

   You can also choose to search for your machine type if the list is long.

4. Click **Alerts**  .
5. Click **Create Alert** + .
6. Specify a **Name** for the alert.

For example, `High Temperature Alert`.

7. (Optional) Select **Required** if every machine of the machine type must associate this attribute with a device alert.

   If you select the **Required** attribute, then you must associate each new machine with a device alert attribute when creating the machine.

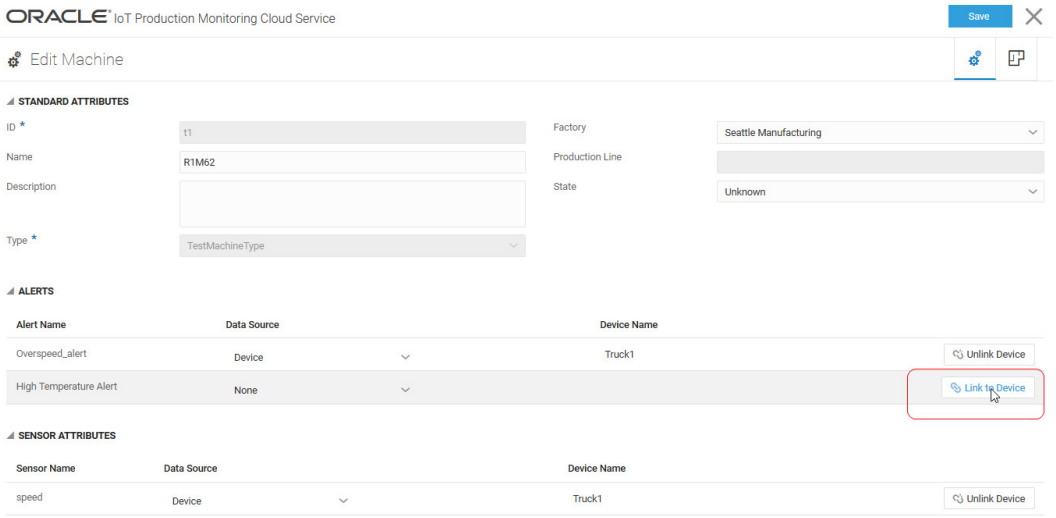
8. Click **Create** to finish creating the alert for the machine type.

Associate a Device Alert with a Machine

To associate a device alert to a machine, you need to link the alert attribute to the corresponding alert attribute for your sensor device.

1. On the Create Machine or Edit Machine page for your machine, click **Link to Device** against the appropriate alert attribute.

   You can access the Machines Page from **Menu > Design Center > Machines**.



2. Select your device from the list of devices.

   You can also filter the list to search for your device.

3. Select the appropriate **Device Model/URN** corresponding to your device.

   Note that you should have already selected the device model for the Oracle IoT Production Monitoring Cloud Service application in your Oracle IoT Cloud Service management console.

4. Under **Format**, select the device alert attribute that corresponds to the alert attribute defined for your machine type.

5. Click **Select** to close the Select Device dialog.

6. Click **Save** on the Create Machine or Edit Machine page.

Define Rules to Trigger Incidents

Trigger an incident when a certain condition that causes a production issue evaluates to true. Maintenance technicians can immediately view the list of incidents from their mobile app to repair the affected machine preventing an outage or minimizing the outage time.

Rules can use conditions based on sensor attribute values, metric values, anomaly conditions, trend values, or prediction values.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Rules**.
4. Click **Create New Rule** .
5. Enter a name to identify this rule.
6. From the **Apply To** list, select one of the following options:
   - Select **Specific Machines,** and then click the field that appears next to it to select a machine.
   - Select **All Machines Within Type,** and then click the field that appears next to it to select a machine type.

     If you select a machine type, the rule applies to all machines of the selected machine type.

     Optionally select **Use Global Metrics** to use a previously defined global metric for the rule condition. Global metrics are calculated for a machine type as a whole, as opposed to metrics that are calculated per machine.
   - Select **Specific Factories,** and then click the field that appears next to it to select a factory.
   - Select **All Machines** if you wish to use an aggregate metric defined for all machines as your rule condition.

     For example, if you have defined an aggregate machine metric to calculate the current average production quantity, you can define a rule to trigger an incident if this number falls below a threshold value.
   - Select **All Factories** if you wish to use an aggregate metric defined for all factories as the rule condition.

     For example, if you have defined an aggregate factory metric to calculate the maximum number of machines that are down currently, you can define a rule to trigger an incident if this number exceeds a threshold value.
   - Select **All Work Orders** if you wish to use work-order metrics as your rule conditions.

     For example, if you have defined a work order metric to calculate the hourly reject percentage for a product, you can define a rule to trigger an incident if the reject percentage exceeds a threshold value.
7. In the **Condition** area select an attribute, a condition, and a value.

   You can apply multiple conditions to the same rule.

You can also use anomaly-based conditions. So, for example, you can configure a condition to trigger the rule if an anomaly occurred in the last one hour.

You can also use prediction value conditions. So, for example, you can configure a condition to trigger the rule if the predicted value for a machine attribute exceeds a threshold value.

You can also use trend-based conditions. So, for example, you can configure a condition to trigger the rule if a trend occurred in the last one hour. You can also selectively select the Nelson rules in the trend that will trigger the rule.

8. In the **Fulfillment** section, from **Fulfill When** select **All Conditions Apply** to trigger the rule if all conditions are true, or **Any Conditions Apply** to trigger the rule if any of the conditions is true.
9. From **Generate**, select **Incident**.
10. In the **Incident Details** section, enter a summary that describes this rule.
11. From the **Type** list select a type of incident.

    Available values are: **Outage**, **Maintenance**, and **Routine**.
12. From the **Priority** list select a priority for this incident.
13. Use the up and down arrows in the **Suppression** field to specify the number of minutes to wait before triggering this incident again after the incident is resolved.
14. (Optional) Add one or more tags.

    You can access these tags using REST APIs or external systems.
15. (Optional) Enter a description.
16. (Optional) Under **Notification Subscription**, add one or more subscriber groups to receive notifications when incidents are triggered by the rule.

    See Use SMS, Email, and HTTP Notifications for more information on configuring notifications.
17. Optionally specify a weekly or monthly schedule during which the rule is in force.

    A rule is active at all times, by default. You can change this behavior to choose a custom schedule for the rule.

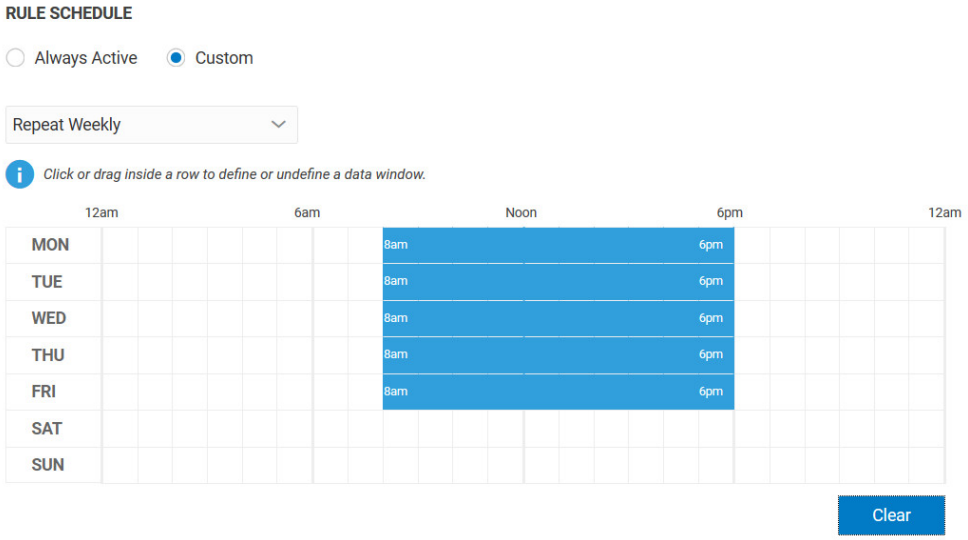
    a. Under Rule Schedule, select **Custom**.

    b. Select **Repeat Weekly** to create a weekly schedule. Alternatively, select **Repeat Monthly** to create a monthly schedule.

    c. Click or drag inside the rows to select a data window.

       You can click an incorrectly selected cell to deselect it. Alternatively, click **Clear** to start afresh.

    The following example shows a weekly schedule for a rule that it is active from 8:00 a.m. to 6:00 p.m. on weekdays.



18. Click **Save**.

You can disable or enable existing rules from the **Rules** page.
The **Rules** page shows you how many incidents were generated since you defined the rule.

Define Rules to Trigger Alerts

Use alerts to trigger other rules or to trigger events in other business applications.

Rules can use conditions based on sensor attribute values, metric values, anomaly conditions, trend values, or prediction values.

1. Click **Menu** ☰ and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Rules**.
4. Click **Create New Rule** + .
5. Enter a name to identify this rule.
6. From the **Apply To** list, select one of the following options:
   - Select **Specific Machines,** and then click the field that appears next to it to select a machine.
   - Select **All Machines Within Type,** and then click the field that appears next to it to select a machine type.

     If you select a machine type, the rule applies to all machines of the selected machine type.

     Optionally select **Use Global Metrics** to use a previously defined global metric for the rule condition. Global metrics are calculated for a machine type as a whole, as opposed to metrics that are calculated per machine.
   - Select **Specific Factories,** and then click the field that appears next to it to select a factory.

- Select **All Machines** if you wish to use an aggregate metric defined for all machines as your rule condition.

  For example, if you have defined an aggregate machine metric to calculate the current average production quantity, you can define a rule to trigger an alert if this number falls below a threshold value.

- Select **All Factories** if you wish to use an aggregate metric defined for all factories as the rule condition.

  For example, if you have defined an aggregate factory metric to calculate the maximum number of machines that are down currently, you can define a rule to trigger an alert if this number exceeds a threshold value.

- Select **All Work Orders** if you wish to use work-order metrics as your rule conditions.

  For example, if you have defined a work order metric to calculate the hourly reject percentage for a product, you can define a rule to trigger an alert if the reject percentage exceeds a threshold value.

7. In the **Condition** area select an attribute, a condition, and a value.

   You can apply multiple conditions to the same rule.

   You can also use anomaly-based conditions. So, for example, you can configure a condition to trigger the rule if an anomaly occurred in the last one hour.

   You can also use prediction value conditions. So, for example, you can configure a condition to trigger the rule if the predicted value for a machine attribute exceeds a threshold value.

   You can also use trend-based conditions. So, for example, you can configure a condition to trigger the rule if a trend occurred in the last one hour. You can also selectively select the Nelson rules in the trend that will trigger the rule.

8. In the **Fulfillment** section, from **Fulfill When** select **All Conditions Apply** to trigger the rule if all conditions are true, or **Any Conditions Apply** to trigger the rule if any of the conditions is true.

9. From **Generate**, select **Alert**

10. In the **Alert Details** section, enter a summary that describes this rule.

11. From the **Severity** list select a severity level for this alert.

12. Use the up and down arrows in the **Suppression** field to specify the number of minutes to wait before triggering this alert again after the incident is resolved.

13. (Optional) Under **Notification Subscription**, add one or more subscriber groups to receive notifications when alerts are triggered by the rule.

    See Use SMS, Email, and HTTP Notifications for more information on configuring notifications.

14. Optionally specify a weekly or monthly schedule during which the rule is in force.

    A rule is active at all times, by default. You can change this behavior to choose a custom schedule for the rule.

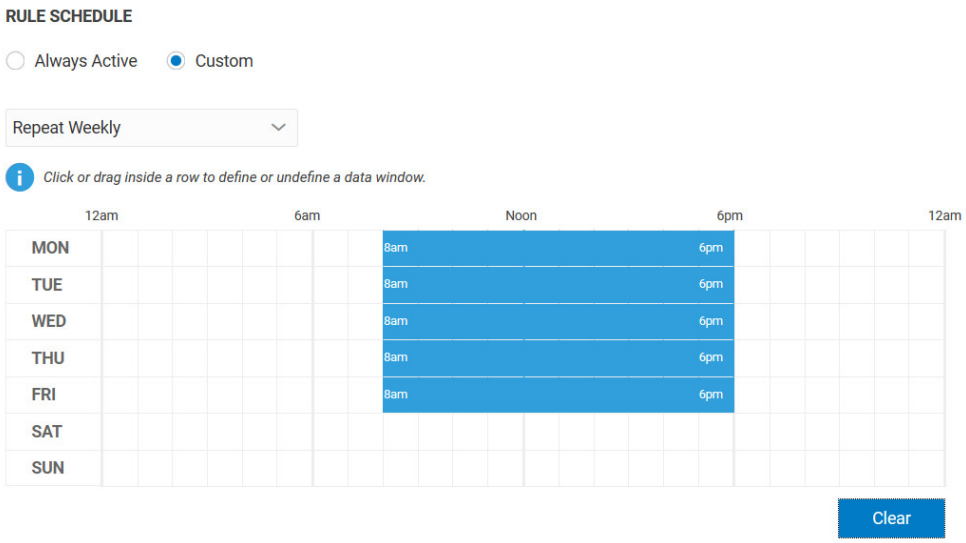
    a. Under Rule Schedule, select **Custom**.

    b. Select **Repeat Weekly** to create a weekly schedule. Alternatively, select **Repeat Monthly** to create a monthly schedule.

    c. Click or drag inside the rows to select a data window.

You can click an incorrectly selected cell to deselect it. Alternatively, click **Clear** to start afresh.

The following example shows a weekly schedule for a rule that it is active from 8:00 a.m. to 6:00 p.m. on weekdays.



15. Click **Save**.

You can disable or enable existing rules from the **Rules** page.
The **Rules** page shows you how many incidents were generated since you defined the rule.

Define Rules to Trigger Warnings

Log events that don't require immediate attention but that might be useful to troubleshoot a production issue.

Rules can use conditions based on sensor attribute values, metric values, anomaly conditions, trend values, or prediction values.

1. Click **Menu** ☰ and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Rules**.
4. Click **Create New Rule** + .
5. Enter a name to identify this rule.
6. From the **Apply To** list, select one of the following options:
   - Select **Specific Machines,** and then click the field that appears next to it to select a machine.
   - Select **All Machines Within Type,** and then click the field that appears next to it to select a machine type.

     If you select a machine type, the rule applies to all machines of the selected machine type.

Optionally select **Use Global Metrics** to use a previously defined global metric for the rule condition. Global metrics are calculated for a machine type as a whole, as opposed to metrics that are calculated per machine.

- Select **Specific Factories,** and then click the field that appears next to it to select a factory.
- Select **All Machines** if you wish to use an aggregate metric defined for all machines as your rule condition.

  For example, if you have defined an aggregate machine metric to calculate the current average production quantity, you can define a rule to trigger a warning if this number falls below a threshold value.
- Select **All Factories** if you wish to use an aggregate metric defined for all factories as the rule condition.

  For example, if you have defined an aggregate factory metric to calculate the maximum number of machines that are down currently, you can define a rule to trigger a warning if this number exceeds a threshold value.
- Select **All Work Orders** if you wish to use work-order metrics as your rule conditions.

  For example, if you have defined a work order metric to calculate the hourly reject percentage for a product, you can define a rule to trigger a warning if the reject percentage exceeds a threshold value.

7. In the **Condition** area select an attribute, a condition, and a value.

   You can apply multiple conditions to the same rule.

   You can also use anomaly-based conditions. So, for example, you can configure a condition to trigger the rule if an anomaly occurred in the last one hour.

   You can also use prediction value conditions. So, for example, you can configure a condition to trigger the rule if the predicted value for a machine attribute exceeds a threshold value.

   You can also use trend-based conditions. So, for example, you can configure a condition to trigger the rule if a trend occurred in the last one hour. You can also selectively select the Nelson rules in the trend that will trigger the rule.
8. In the **Fulfillment** section, from **Fulfill When** select **All Conditions Apply** to trigger the rule if all conditions are true, or **Any Conditions Apply** to trigger the rule if any of the conditions is true.
9. From **Generate**, select **Warning**.
10. Specify a **Summary** text for the warning.
11. (Optional) Enter a **Description** for the warning.
12. From the **Level** list select a priority for this incident.
13. Use the up and down arrows in the **Suppression** field to specify the number of minutes to wait before triggering this incident again after the incident is resolved.
14. (Optional) Add one or more **Tags**.

    You can access these tags using REST APIs or from external systems.
15. (Optional) If you select **Auto Delete on Resolve**, then resolved warnings are deleted automatically.

    You can also manually delete active and resolved warnings.

16. (Optional) Under **Notification Subscription**, add one or more subscriber groups to receive notifications when warnings are triggered by the rule.

    See Use SMS, Email, and HTTP Notifications for more information on configuring notifications.

17. Optionally specify a weekly or monthly schedule during which the rule is in force.

    A rule is active at all times, by default. You can change this behavior to choose a custom schedule for the rule.

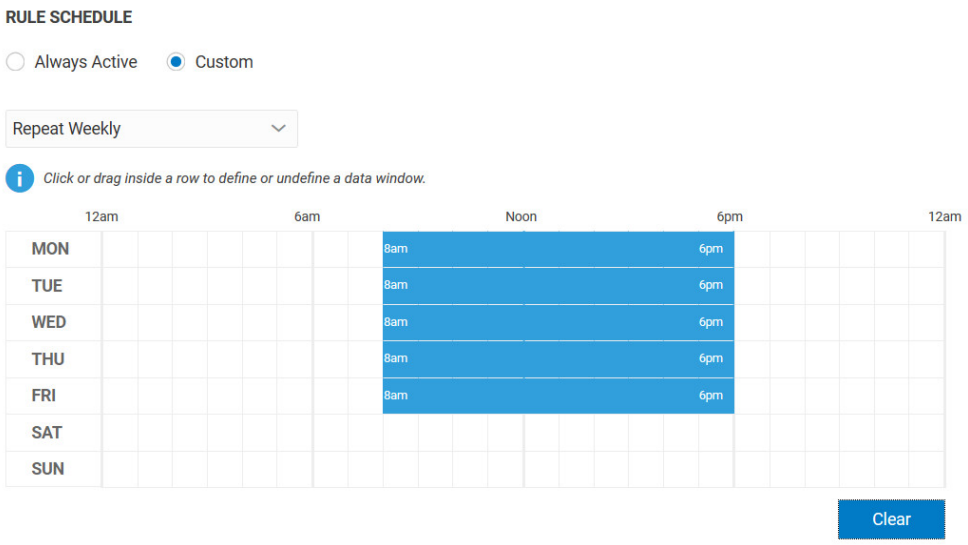
    a. Under Rule Schedule, select **Custom**.

    b. Select **Repeat Weekly** to create a weekly schedule. Alternatively, select **Repeat Monthly** to create a monthly schedule.

    c. Click or drag inside the rows to select a data window.

       You can click an incorrectly selected cell to deselect it. Alternatively, click **Clear** to start afresh.

    The following example shows a weekly schedule for a rule that it is active from 8:00 a.m. to 6:00 p.m. on weekdays.



18. Click **Save**.

You can disable or enable existing rules from the **Rules** page.
The **Rules** page shows you how many incidents were generated since you defined the rule.

Use Contextual Parameters in Warnings and Incidents

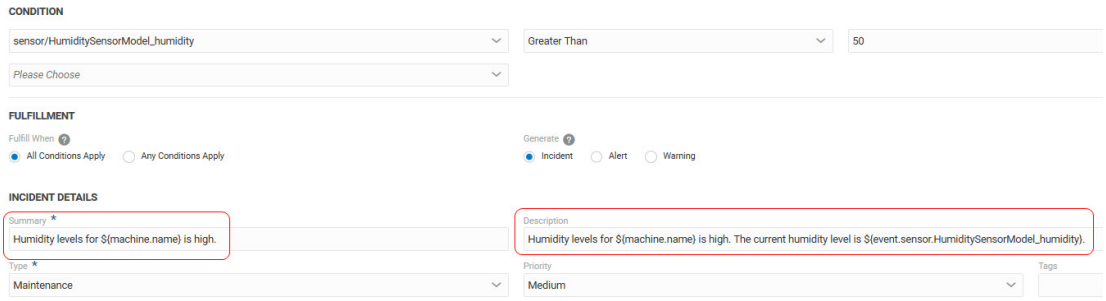
When creating rules, you can use dynamic contextual parameters in the incident and warning details.

Contextual parameters can include variables, such as machine names, sensor values, and metric values. These variables are dynamically resolved each time the rule is triggered.

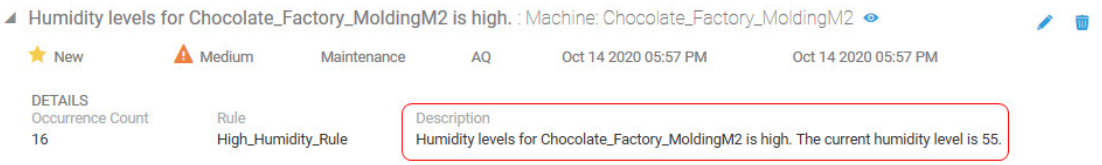
The following warning and incident fields can include dynamic contextual parameters:

- **Summary**
- **Description**

Here's an example of the rule configuration screen containing dynamic contextual parameters in the **Summary** and **Description** fields:



And here's an actual Incident created by the preceding rule:



The following contextual parameters can dynamically retrieve machine, sensor, metric, and rule related information:

- Machine Parameters
  - `${machine.name}`: Retrieves the name of the machine for which the warning or incident is generated.

    For example: `The machine ${machine.name} has low fuel.`

    May translate to:

    `The machine Power_Factory_Generator1 has low fuel.`
  - `${machine.id}`: Retrieves the ID of the machine for which the warning or incident is generated.
  - `${machine.displayName}`: Retrieves the display name of the machine for which the warning or incident is generated.
  - `${machine.productionLine}`: Retrieves the name of the production line to which the machine belongs.
  - `${machine.description}`: Retrieves the description string for the machine.
  - `${machine.state}`: Retrieves the current state of the machine, say, whether the machine is in use, idle, or down.
  - `${machine.type}`: Retrieves the machine type ID (GUID).
  - `${machine.factory}`: Retrieves the name of the factory to which the machine belongs.

- Sensor Parameters
  - `${event.sensor.attributeName}`: Retrieves the value of the specifed sensor attribute name.

    For example: `The machine ${machine.name} has low fuel level: ${event.sensor.fuel}%.`

    May translate to:

    `The machine Power_Factory_Generator1 has low fuel level: 10%.`

    Here, `fuel` is a sensor attribute for the machine.
- Metric Parameters: You can use metric-related parameters only if the rule condition uses the metric.
  - `${event.metric.name}`: Retrieves the name of the metric that triggered the rule.
  - `${event.metric.value}`: Retrieves the value of the metric that triggered the rule.

    For example: `${event.metric.name} for ${machine.name} is High: It is ${event.metric.value}.`

    May translate to:

    `Average Temperature for Power_Factory_Engine1 is High: It is 150.`
- Rule Parameter

  `${rule.id}`: Retrieves the ID (GUID) of the rule for which the warning or incident is generated.

Use Built-In Functions to Format Your Contextual Parameters

You can choose to use built-in functions to format the output of your contextual parameters.

For example, string keys can use the following format options:

- `${machine.displayName?cap_first}` converts the first letter of the string to uppercase.
- `${machine.displayName?uncap_first}` converts the first letter of the string to lowercase.
- `${machine.displayName?capitalize}` converts the string into title case (the first letter of every word is capitalized).
- `${machine.displayName?lower_case}` converts the string to lowercase.
- `${machine.displayName?upper_case}` converts the string to uppercase.
- `${machine.displayName?remove_beginning("STRING")}` removes the specified sub string from the beginning of the string.
- `${machine.displayName?remove_ending("STRING")}` removes the specified sub string from the end of the string.
- `${machine.displayName?trim}` removes any leading and trailing white spaces from the string.

The following examples describe some available format options for number outputs:

- `${event.sensor.<sensor_name>?abs}` converts a number to its absolute (non-negative) value.
- `${event.sensor.<sensor_name>?c}` converts a numeric value to the *computer language* value, as opposed to the default human readable format. Doesn't use grouping separators (commas, for example), uses dot as a decimal separator. Prints up to 16 digits after the dot. Never uses exponential form.
- `${event.sensor.<sensor_name>?round}` rounds the number to the nearest whole number. In case a decimal number ends with .5, rounds it to the next whole number.
- `${event.sensor.<sensor_name>?floor}` rounds the number downwards.
- `${event.sensor.<sensor_name>?ceiling}` rounds the number upwards.

7

Understand Factory Performance

Use anomalies and predictions to track and predict machine and factory behavior. Use contextual data sets to access factory and machine data from external systems and use these for metric computations and analytics.

Topics

- Use Anomalies to Track Deviations in Machines and Factories
- Use Predictions
- Use Contextual Data Connections

Use Correlation Analysis for Your IoT Sensor Attributes

Use correlation analysis for your machine sensor attributes to visualize and understand the relationships between the various attributes. Correlation analysis can help determine optimal operating and maintenance parameters for your machine. Correlation analysis can also help determine the variables that correlate with unexpected machine failure.

Correlation analysis lets you explore the relationships between the available IoT data measurements and get insights into machine behavior. Correlation analysis also helps perform what-if scenario analyses and root cause diagnostics. Use correlation analysis to help set up your control systems, set up multivariate anomaly detection, and state-aware anomalies.

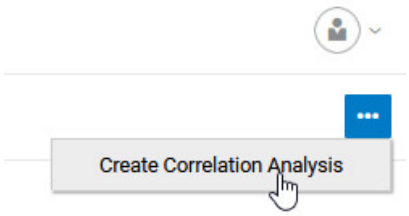
Create a Correlation Analysis for a Machine Type

Create a correlation analysis for a machine type to study the correlation between a target sensor attribute and one or more influencing sensor attributes.

You can apply the correlation analysis to all machines of the machine type, or apply it to specific machines that you wish to study. Use the Machine Types page in Design Center to create the correlation analysis.

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** sub-menu.
3. Select a machine type from the **Machine Types** list.

   You can also search for a machine type.
4. Click **Correlation Analysis**.
5. On the Correlation Analysis page, select **Create Correlation Analysis** from the Correlation Analysis menu.



The Correlation Analysis editor appears.

6. In the Correlation Analysis editor, specify a **Name** and **Description** for the correlation analysis under the **Details** section.
7. Select a value for the **Publish Results To** field.

   When first creating a correlation analysis, you may want to publish it to **Design Center** only. After you have viewed and analyzed the results, you may want to edit the value to **Operations Center**, so that the results appear in the Operations Center view as well.
8. Under **Target**, choose whether you want the analysis to apply to all machines or specific machines of the machine type.

   Select **All machines of type: *MachineType*** to apply the analysis to all machines. Alternatively, select **Specific machines of type: *MachineType*** to choose the specific machines to analyze.
9. Under **Time Window** in the **Configuration** section, choose the time duration for which to analyze the data.

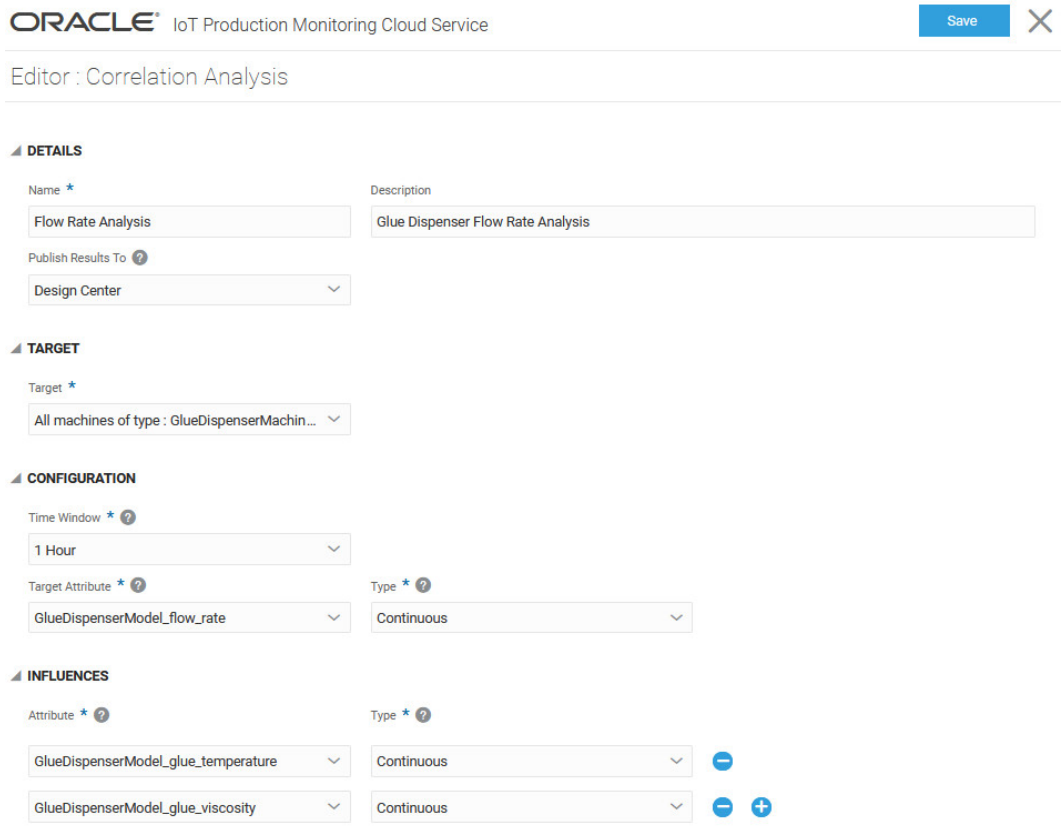
   For example, choosing **One Hour** will analyze the last hour's data for the chosen machines when you run the analysis.
10. Under **Target Attribute**, select the sensor attribute that you wish to analyze.
11. Choose the data **Type** for the target attribute.

    Choose **Continuous** if the attribute can take continuous real numbered values. For example, 10.6. Choose **Categorical** if the attribute can take only discrete values. For example, values such as 'High', or '100'.
12. Under the **Influences** section, select one or more sensor attributes that can influence the target attribute.

    After selecting each **Attribute**, select the corresponding type, continuous or categorical, before adding another influencing attribute.

    You can add both continuous and categorical influencing attributes.

    The following correlation analysis editor shows a correlation analysis created to observe the effects of change in viscosity and temperature on the flow-rate for a glue dispenser machine.



13. Click **Save** to create the correlation analysis.

The correlation analysis appears as a new row on the Correlation Analysis page for the machine type.

Run and View a Correlation Analysis

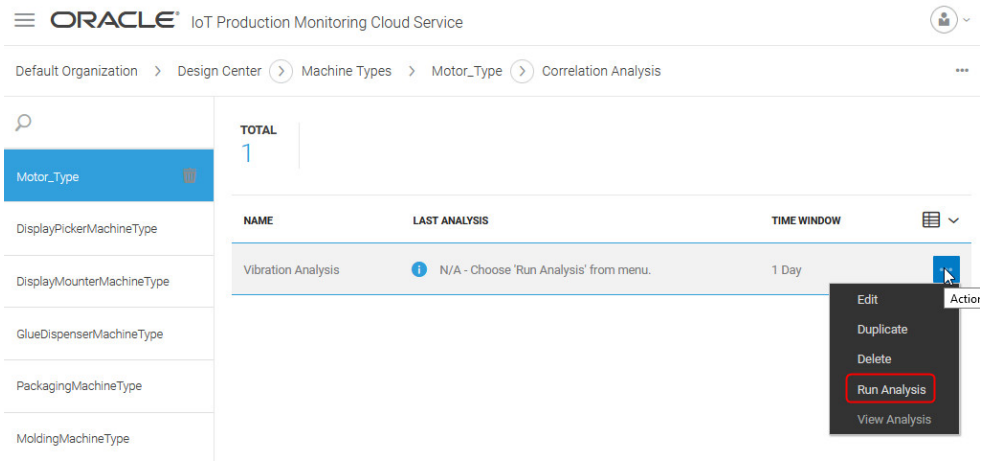
Run a correlation analysis in Design Center to study the correlation between the selected target and influencing attributes. Depending on your correlation settings, the results of the analysis can also be viewed in the Operations Center.

You can run a previously created correlation analysis from the Correlation Analysis page for the machine type.

1. Navigate to the Correlation Analysis page for your machine type.

   Click **Menu > Design Center > Machine Types > *Machine Type Name* > Correlation Analysis** to navigate to the correct page.

2. Select **Run Analysis** from the **Actions** menu for the correlation analysis row.



> **Note:**
>
> You can also **Edit** the correlation analysis settings from the **Actions** menu.

The Last Analysis column status changes to *Computation in Progress*.

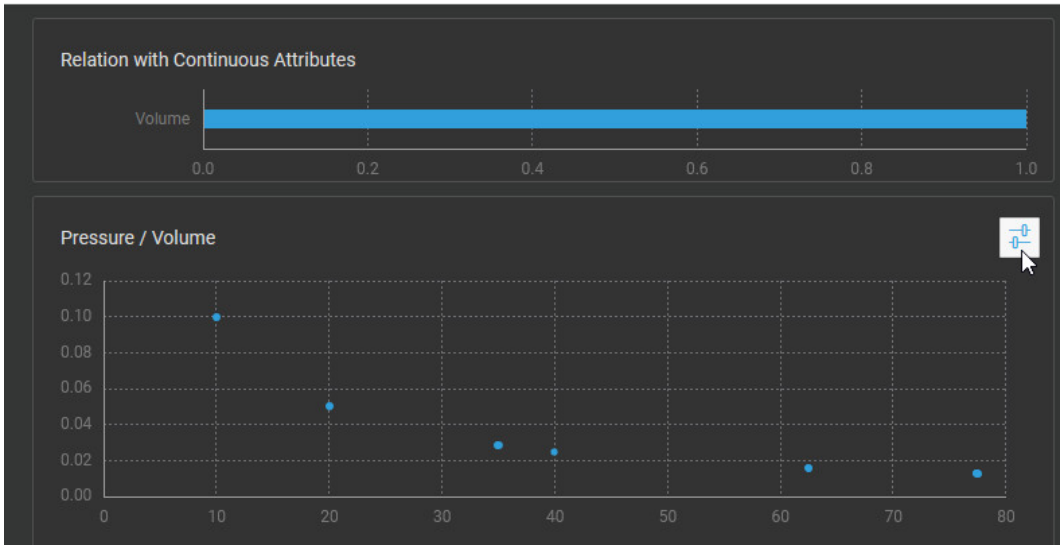
The computation takes between a few seconds to a few minutes. If you navigate away from the page and navigate back to it, you should see the last analysis status as complete along with the timestamp when the analysis completed.

3. To view a completed analysis, click the **Actions** menu against the correlation analysis row, and select **View Analysis**.

   The results of the correlation analysis between the target attribute and each influencing attribute appears. For each pair of target and influencing attribute, a correlation value between 0 (no observable correlation) and 1 (close correlation) is returned.

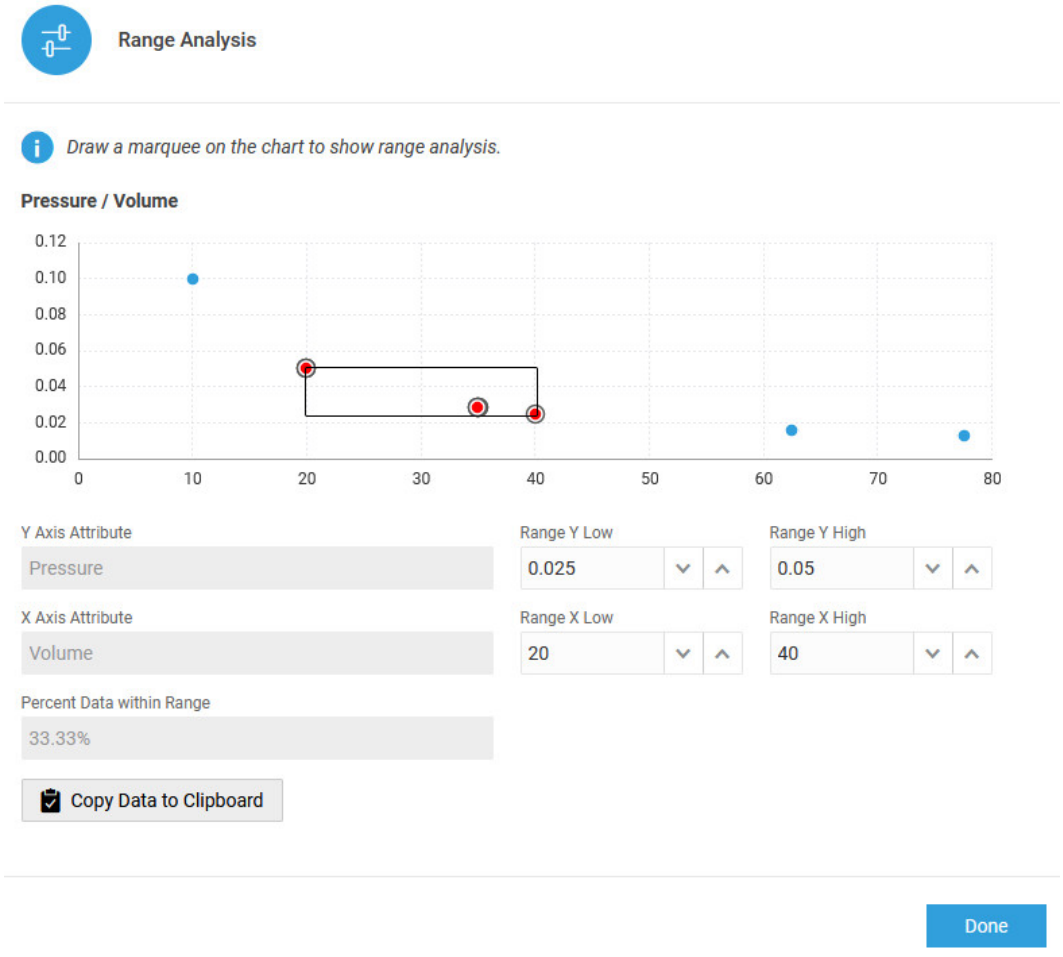
   For each pair of target and influencing attribute, a chart of correlation data is returned. You can also perform additional range analysis by manually selecting the range of values of interest.

   The following example shows a correlation analysis between the Pressure and Volume sensor attributes.

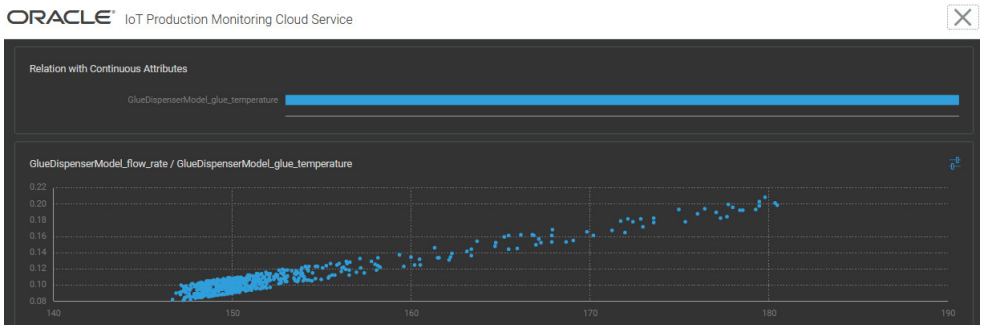


A close correlation can be seen between the attributes, as the pressure decreases with increasing volume.

Selecting the Range Analysis button lets you manually select the values of interest.



The following example shows the correlation analysis for a glue dispenser. The correlation of the flow rate attribute is studied against the temperature attribute.

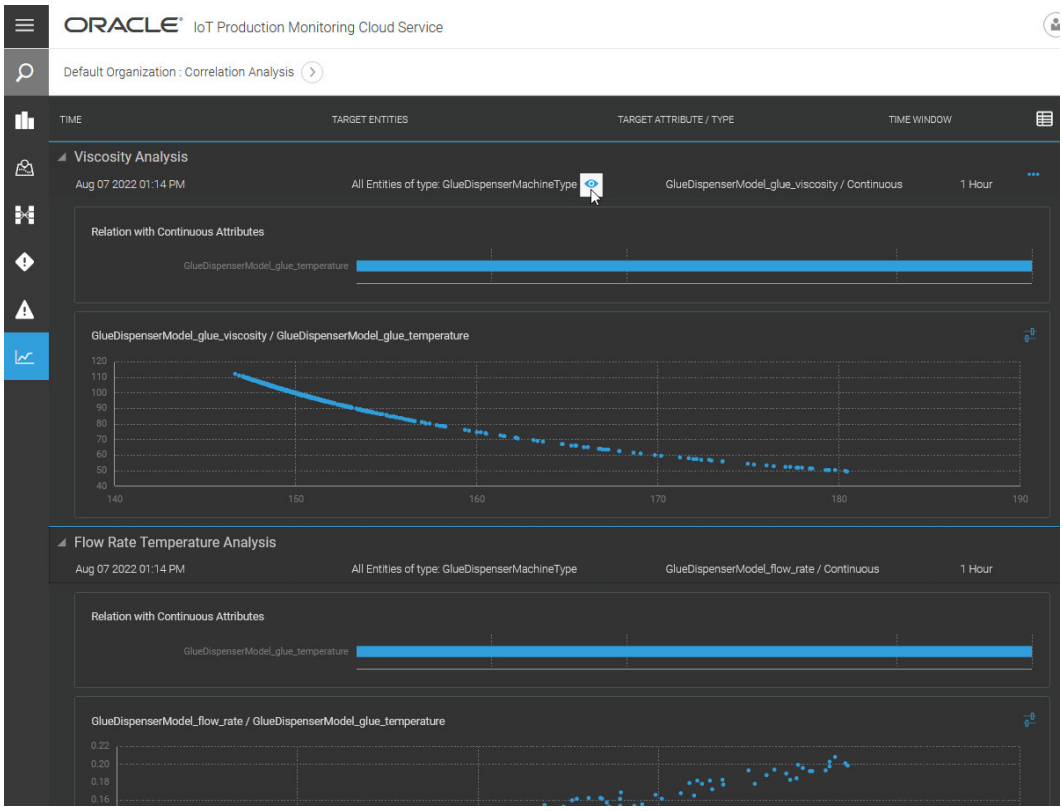


As evident from the correlation chart, there is a strong correlation between flow-rate and temperature: The flow rate increases, almost linearly, with temperature. If the ideal flow rate is between 0.9 and 0.14, then the temperature should be maintained between 150 and 160.

4. To view the correlations in Operations Center, click **Correlations** in the Operations Center menu bar.

   To navigate to Operations Center, click **Menu > Operations Center**.

> **Note:**
>
> The **Correlations** button appears in the Operations Center menu bar if you have chosen to publish the results of the correlation analysis to the Operations Center in the correlation analysis settings.



Click the **View** icon under Target Entities to select and view the correlation analysis for a specific machine.

Use Anomalies to Track Deviations in Machines and Factories

When the set parameters of a machine or factory do not conform to a regular pattern, an anomaly occurs. An anomaly can help you identify and resolve potential problems with your machines and factories.

Use anomalies to detect deviations from normal behavior, and to flag and address issues in time. As a factory manager, you can also detect anomalies for data streams where the data is not normally distributed (non-Gaussian distribution).

You can define the following types of anomalies:

- **Automatic Anomaly:** Use an automatic anomaly to automatically look for deviations in a sensor or metric (KPI) value. For example, automatic anomalies can help detect a machine that is overheating.

  Sometimes, a set of correlated sensor signals can help identify issues with your machine. For example, a drop in pressure readings coupled with an increase in vibration may indicate cavitation issues in a pump. You can use multivariate automatic anomalies to monitor multiple sensor attributes and metrics simultaneously. Use the Operations Center to view the reported anomalies on the timeline, together with the key signals from your chosen sensor and metric attributes.

  Machine sensor values can depend on the machine state. For example, an idling motor has different vibration measurements from a motor running with load. Machine sensor values may also vary with the current process, product being produced, or environmental

attributes. For example, the baseline fuel consumption may depend on the ambient temperature. The injection pressure of a molding machine may depend on whether it is currently molding steel or aluminum bottles.

If the current machine state determines the threshold sensor values for your anomalies, you can use partition key attributes to partition your anomalies. For example, you can create partitions to look at vibration anomalies when the motor is working, and ignore states where the motor is idling, or under maintenance.

See Define an Automatic Anomaly for more information on defining automatic anomalies.

- **User-Defined Anomaly:** Create a user-defined anomaly to look for telltale patterns in sensor or metric data generated by a machine. For example, you may create anomalies to look for vibration anomalies in a packaging machine. User-defined anomalies are based on acceptable or anomalous data patterns. You train the system by providing it with samples of acceptable data or anomalous data. These samples can come from sensor or metric data.

  For acceptable data, you specify a time window containing acceptable patterns of sensor or metric data. The time window is a period of typical operations during which your machines, and associated sensors, behaved normally. The system uses the data pattern that you select to train itself. During day-to-day operations, the system looks out for deviations in data patterns that are beyond the specified deviation percentage, and flags these as anomalies.

  For anomalous data, you train the system by providing it with samples of anomalous data patterns from existing sensor or metric data.

  See Create a User-Defined Anomaly for more information on defining user-defined anomalies.

View Anomalies

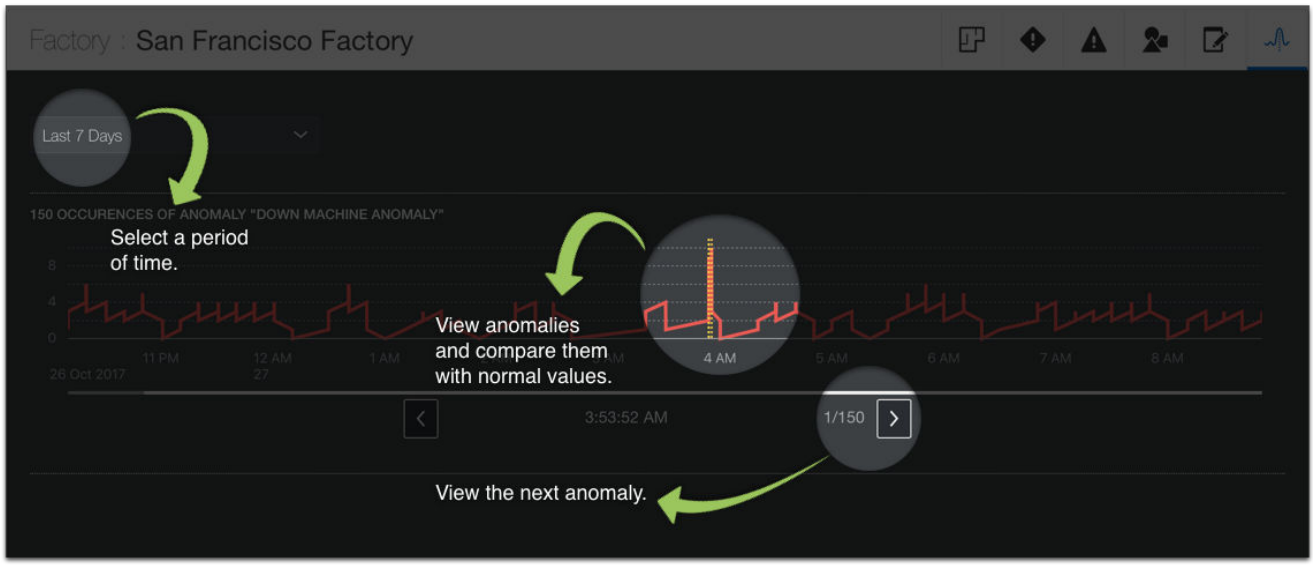
View the anomalies for a machine or factory to identify any unusual behavior that might affect the performance of your machine or factory.

In the **Factory** view, select the **Anomalies** tab. Then select a period to view, you can view the anomalies for the last hour, the last day, the last week, or the last month. Use the arrows to view the next or the previous anomaly.

Anomalies are displayed with a different color and a dotted line. The solid lines shows the normal values. Use the normal values to understand the importance of the anomalies you are viewing.

The horizontal axis shows the time so that you can identify the time at which the anomaly occurred. Browsing through the different anomalies you can also find out their frequency.

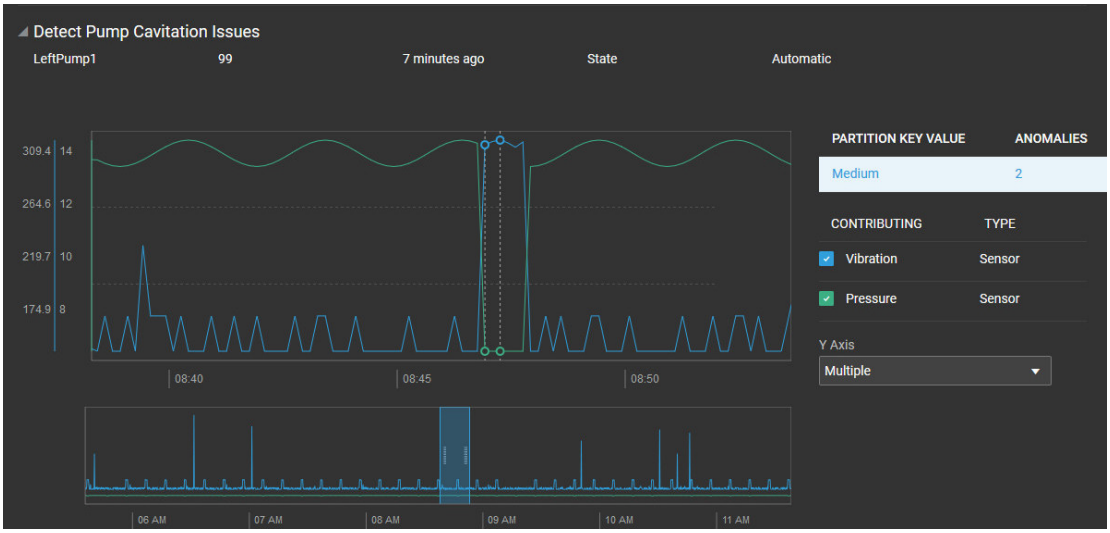
This image shows you the available actions in the **Anomalies** view:



The following Operations Center view shows multivariate anomalies for a pump device. Notice that you can select the sensor signals that you wish to view in the chart. If you are using partition key values corresponding to asset states, then you can select the relevant partition key as well.

> **Note:**
>
> To view anomalies for a specific factory or machine in Operations Center, use the breadcrumbs to navigate to your factory or machine, and click the **Anomalies** tab.

If the sensor values are disparate, you can choose multiple y-axes, so that you can see each signal using the correct scale.



Define an Automatic Anomaly

Define an automatic anomaly to automatically identify deviations in sensor attributes or metrics.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Anomaly Detection** .
4. Click **Create Anomaly** .

   The Anomaly Detection Editor appears.
5. Enter a name for the anomaly in the **Name** field.
6. (Optional) Specify an optional **Description** text for the anomaly.
7. (Optional) Select a value under **Keep Metric Data For**.

   If you have unique storage requirements for historical data related to this anomaly, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

   For example, if you are calculating anomalies across a large number of machines, and the anomaly data is not required beyond a month, then you can select **30 Days** under **Keep Metric Data For** to optimize storage.
8. Select the **Machine Type** for your anomaly.

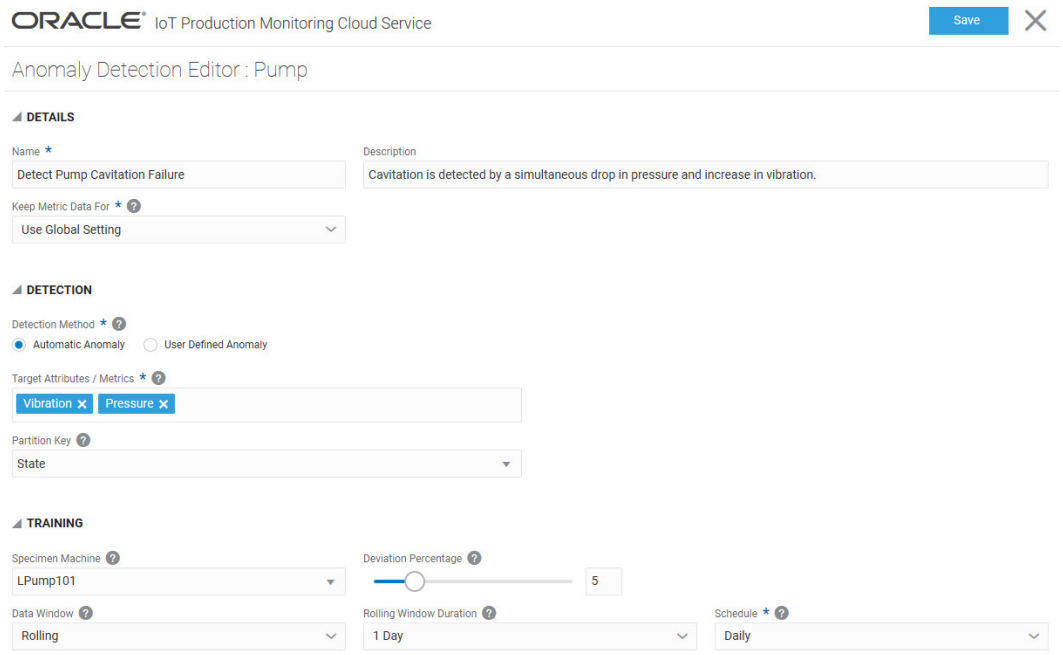
   The anomaly applies to all machines of the chosen machine type.

   Note that you can also select **All Factories** if you wish to choose a pre-defined factory metric as the attribute.
9. Under Detection, select **Automatic Anomaly** as the **Detection Method**.

   Use an automatic anomaly to automatically look for deviations in a sensor or metric (KPI) value. For example, automatic anomalies can help detect a machine that is overheating intermittently.
10. Under Detection, select one or more available **Target Attributes/Metrics** to monitor.

    The list of attributes includes sensor attributes and query-type (computed) metrics.

    The following example uses the Vibration and Pressure sensor attributes:



In case you selected **All Factories** under **Machine Type**, then the following list of pre-defined factory metric attributes is available:

- **Total Machines Down**: Number of unavailable machines in the factory.
- **Total Idle Machines**: Number of machines in idle state in the factory.
- **Machines in Use Percentage**: Percentage of machines in use in the factory.
- **Machines Idle Percentage**: Percentage of machines in idle state in the factory.
- **Machines Down Percentage**: Percentage of unavailable machines in the factory.
- **Total In Use Machines:** Number of machines in use in the factory.

11. (Optional) If you have defined sensor attributes that can be used as partition keys to determine the machine state, then you can choose the **Partition Key**.

    For example, you may have defined a sensor attribute called *State* to determine whether the machine is currently running, idling, or under maintenance.

> **Note:**
>
> The machine type must have at least one sensor attribute that can be used as the partition key. See Create Machine Types for more information on sensor attributes.

12. Under Training, select a **Specimen Machine** that provides the training data for anomaly detection.

> **Note:**
>
> If you selected **All Factories** under **Machine Type**, then the **Specimen Factory** field appears in place of Specimen Machine.

A list of all machines with the selected machine type appears. The machine with the most data is chosen by default. You can choose a different machine if required.

13. Under Training, select a **Deviation Percentage**.

    The deviation percentage is the threshold deviation percentage in attribute value that triggers the anomaly.

    If you are using multiple **Target Attributes** and/or **Partition Key**, then the deviation percentage refers to the percentage of anomalous data that triggers the anomaly.

    Use the slider to set a value, or enter a value manually.

14. Under Training, select the **Data Window**.

    The **Data Window** identifies the data set that is used to train the system for anomaly detection.

    - **Static**: Uses a static data window to train your anomaly model. If you have golden data from a period when your machine worked normally, you can use the same to specify a static window. Select the **Window Start Time** and **Window End Time** for your static window period.
      The static data window provides data for a one-time training of your anomaly model. If your definition of normal data changes in the future, you should edit the **Data Window** for the automatic anomaly, so that the model can be re-trained.
    - **Rolling**: A rolling data window uses data from a rolling time window to pick the most recent data for training. For example, you can choose to train your anomaly model with a rolling data window of the last 7 days, and choose to perform the anomaly training daily.
      When you use a rolling window, the training model is re-created periodically, as determined by the schedule frequency that you choose.
      - **Rolling Window Duration**: The duration of the rolling window going back from the model training time. For example, if you select **7 Days**, then the last 7 days of specimen machine data is used to train the anomaly model.
      - **Schedule**: The frequency of the anomaly model training. For example, if you choose **Daily**, then the training happens every day at 00:00 hours (midnight), UTC time by default.

15. Click **Save**.

16. Close the Anomaly Detection Editor window.

The anomaly is added to the Anomaly Detection page. The **Training Status** column shows the latest training status for the anomaly model. Once training is complete, the application starts detecting and reporting anomalies.

Create a User-Defined Anomaly

Create a user-defined anomaly to look for patterns in sensor data generated by a machine.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Anomalies**.
4. Click **Add** .
5. Enter a name for the anomaly in the **Name** field.
6. (Optional) Specify an optional **Description** text for the anomaly.
7. (Optional) Under Configuration, select a value under **Keep Metric Data For**.

   If you have unique storage requirements for historical data related to this anomaly, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

   For example, if you are calculating anomalies across a large number of machines, and the anomaly data is not required beyond a month, then you can select **30 Days** under **Keep Metric Data For** to optimize storage.
8. Under Configuration, select the **Machine Type** for your anomaly.

   The anomaly applies to all machines of the chosen machine type.

   Note that you can also select **All Factories** if you wish to choose a pre-defined factory metric as the attribute.
9. Select an available **Attribute** to monitor.

   The list of attributes includes sensor attributes and query-type (computed) metrics.

   If you selected **All Factories** under **Machine Type**, then the following list of pre-defined factory metric attributes is available:

   - **Total Machines Down**: Number of unavailable machines in the factory.
   - **Total Idle Machines**: Number of machines in idle state in the factory.
   - **Machines in Use Percentage**: Percentage of machines in use in the factory.
   - **Machines Idle Percentage**: Percentage of machines in idle state in the factory.
   - **Machines Down Percentage**: Percentage of unavailable machines in the factory.
   - **Total In Use Machines:** Number of machines in use in the factory.
10. Under **Method**, select **User Defined Anomaly.**

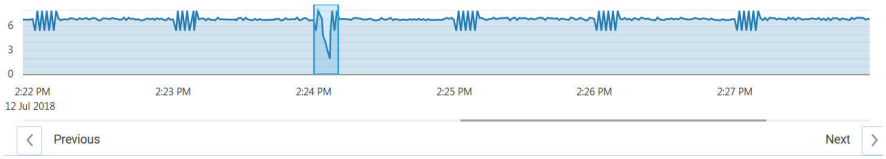
    Create a user-defined anomaly to look for telltale patterns in sensor or metric data generated by a machine. For example, you may use manual anomalies to look for vibration anomalies in a packaging machine. User-defined anomalies are based on acceptable or anomalous data patterns. You train the system by providing it with samples of acceptable data or anomalous data. These samples can come from sensor or metric data.
11. Select a **Specimen Machine** that provides the data pattern for anomaly detection.

A list of all machines with the selected machine type appears. The machine with the most data is chosen by default. You can choose a different machine if required.

12. Under **Training**, choose a **Selection Type,** and complete the corresponding steps.

- Choose **Anomalous Data** to select an anomalous data pattern from existing sensor or metric data.
  a. (Optional) Change the **Data End Time** for the chart, if required. The current date and time are automatically populated.
  b. Click **Generate Chart** to display the sensor or metric data for the selected attribute and asset.

     The data plot for the selected machine attribute appears.
  c. Use the mouse to select the anomaly pattern in the data plot.



     You can zoom in and zoom out in the data plot area. You can also navigate along the time axis using the **Next** and **Previous** buttons.

     If you wish to change the selected pattern, you can select another pattern in the data plot and the first pattern is deselected.
  d. Click **Save** to save the anomaly.
- Choose **Acceptable Data** to select acceptable or non-anomalous data from existing sensor or metric data.
  a. Select a **Deviation Percentage.**

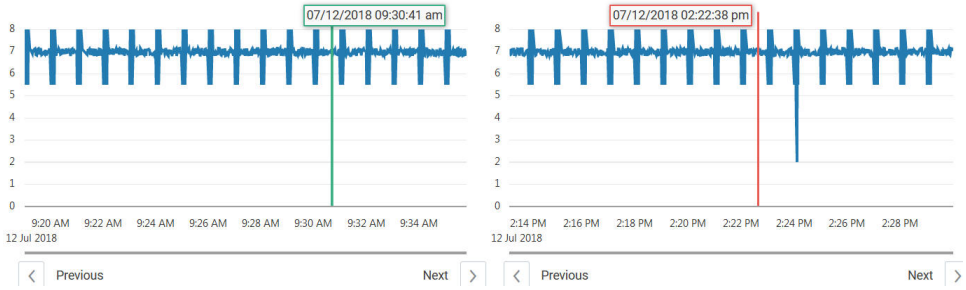
     This is the percentage of deviation required to trigger an anomaly.
  b. Specify a **Data Start Time** and **Data End Time** to plot the chart.

     This is the broad time period that contains acceptable, or non-anomalous, attribute data.
  c. Click **Generate Chart** to display the sensor or metric data for the selected attribute and time period.

     The data plot for the selected asset attribute appears.
  d. Click within the left-half chart to select the start time.

     This marks the beginning of acceptable, or non-anomalous, data.
  e. Click within the right-half chart to select the end time.

     This marks the end of the sample (acceptable) data.



f. Click **Save** to save the anomaly.

Use Predictions

Predictions use historical and transactional data to predict future machine-related metrics, and to identify potential risks to your machines.

Use predictions to identify risks, carry out proactive maintenance of machines, and avoid product delivery delays. Predictions help you create and meet your production plans. Predictions help warn you of impending machine failure in advance. Preventive maintenance can help save the costs associated with machine breakdown or unavailability.

View Predictions

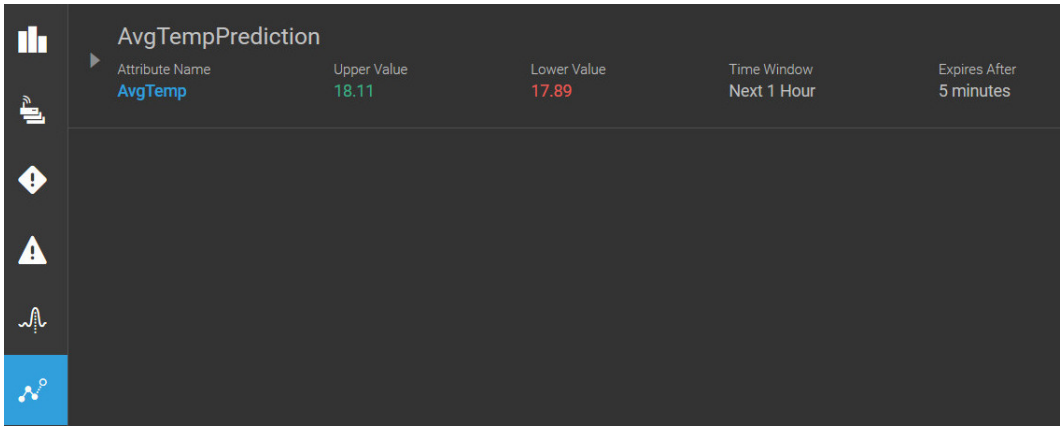
You can view the predictions for a machine under the Predictions tab of the machine view.

1. In the **Floor Plan** view, or in the **Production** view for a factory, click the icon for the machine you want to monitor.

2. Click **Predictions** in the menu bar.

   The available predictions, if any, for the machine appears. A prediction value includes the upper and lower limits of the prediction range along with the duration for which the prediction is valid. The prediction range is calculated based on the predicted value and the accuracy supplied by the server. For example, if the accuracy of your current prediction model is 90% and the predicted value is 10, then the prediction range is between 9 and 11.

   Here's a sample prediction based on the average temperature metric:



3. (Optional) Expand the prediction to see the data plot for the sensor or metric attribute along with the predicted values.

   Here's an expanded prediction sample:

   The sensor data plot for the `Temperature` sensor and the data plot for the `AvgTemp` metric are shown in green and blue respectively. The `Lower Value` and `Upper Value` predictions for the hourly `AvgTemp` also appear against the data plot. These are shown as dashed lines.

   In the current example, the prediction is due to be refreshed in another 5 minutes. You can optionally select **Historical Predictions** to see past predictions.

Define a Prediction

Predictions use historical and transactional data to predict future machine-related metrics, and to identify potential risks to your machines. Create a Prediction in the Design Center.

1. Click **Menu** ☰ and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.

   You can also select **Machine Types** to open the Machine Types page. You can then select an existing machine type and create a prediction for it.

3. Click **Predictions** .
4. Click **Add** + .
5. Specify a **Name** for the prediction.
6. (Optional) Enter a **Description** for this prediction.
7. (Optional) In the Configuration section, select a value under **Keep Metric Data For**.

   If you have unique storage requirements for historical data related to this prediction, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

For example, if you are making frequent predictions across a large number of machines, and the prediction data is not required beyond a month, then you can select **30 Days** under **Keep Metric Data For** to optimize storage.

8. In the configuration section, select the **Machine Type** to which the prediction applies.
9. Under **Model**, leave **Automatic Model** selected.
10. Under **Target Attribute**, select the **Sensor** or **Metric** for which you wish to predict the value.

    You cannot use on-demand metrics for predictions. The metric must be a scheduled metric.
11. Under **Forecast Window**, select one of the options:
    - **1 Hour Ahead**: Select this option to create a prediction for the next one hour.
    - **24 Hours Ahead**: Select this option to create a prediction for the next 24 hours.
    - **7 Days Ahead**: Select this option to create a prediction for the next 7 days.
    - **30 Days Ahead**: Select this option to create a prediction for the next 30 days.

    > **Note:**
    >
    > The options that appear depends upon the data life span settings for your device data and metric data. These settings can be managed under **Menu > Settings > Storage Management**.

12. Select a **Reporting Frequency** for the prediction.

    For example, if you choose a **Forecast Window** of **24 Hours Ahead** and a **Reporting Frequency** equal to **Hourly**, then the prediction for 24 hours ahead is made every hour.
13. Under Training, select the **Data Window**.

    The **Data Window** identifies the historical data that is used to train the system for making predictions.
    - **All Available Data**: Uses the entire available historical data to train the prediction model.
    - **Rolling**: A rolling data window uses data from a rolling time window to pick the most recent data for training. For example, you can choose to train your prediction model with a rolling data window of the last 7 days, and choose to perform the prediction training daily.
      When you use a rolling window, the training model is re-created periodically, as determined by the frequency that you choose.
      - **Frequency**: You can optionally change the frequency of the prediction model training. For example, if you choose **Daily**, then the training happens every day at 00:00 hours (midnight), UTC time by default.
      - **Rolling Window Duration**: The duration of the rolling window going back from the model training time. For example, if you select **7 Days**, then the last 7 days of target attribute data is used to train the prediction model.
    - **Static**: Uses a static data window to train your prediction model. Select the **Window Start Time** and **Window End Time** for your static window period.
      The static window duration must be at least three times the **Forecast Window**, and a minimum of 72 hours.

The static data window provides data for a one-time training of your prediction model. If your prediction accuracy changes in the future, you should edit the prediction to choose a different static window.

14. Click **Save** to save the prediction.

Define a Prediction Using an Externally Trained Model

If you have a PMML file containing your externally trained model, you can use the PMML file to score your prediction in Oracle IoT Production Monitoring Cloud Service.

By default, Oracle IoT Production Monitoring Cloud Service uses the most appropriate built-in training model to train the prediction. However, if your data scientists have externally trained models for your specific environment, you can use these to replace the training in Oracle IoT Production Monitoring Cloud Service. Oracle IoT Production Monitoring Cloud Service then performs the prediction scoring using your pre-trained model.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.

   You can also select **Machine Types** to open the Machine Types page. You can then select an existing machine type and create a prediction for it.

3. Click **Predictions** .
4. Click **Add** .
5. Specify a **Name** for the prediction.
6. (Optional) Enter a **Description** for this prediction.
7. (Optional) In the Configuration section, select a value under **Keep Metric Data For**.

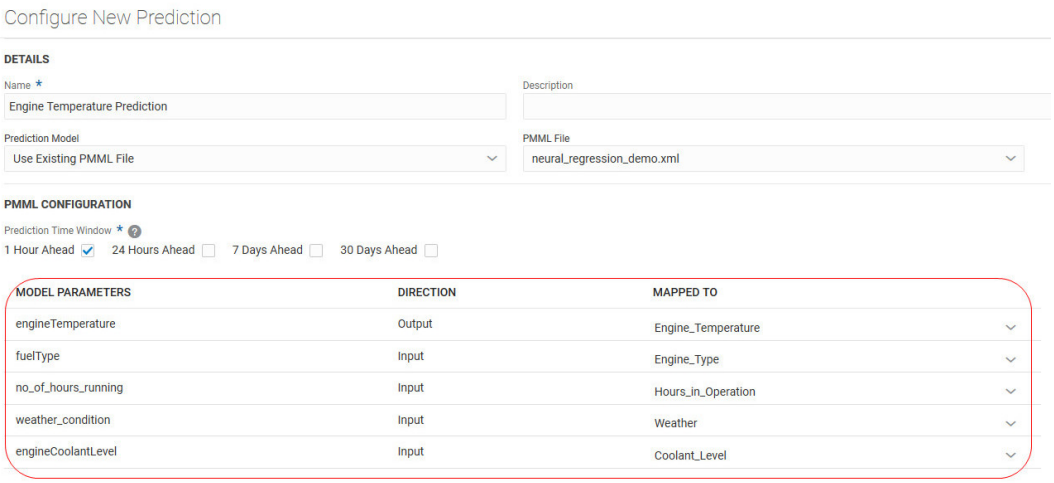
   If you have unique storage requirements for historical data related to this prediction, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

   For example, if you are making frequent predictions across a large number of machines, and the prediction data is not required beyond a month, then you can select **30 Days** under **Keep Metric Data For** to optimize storage.
8. In the configuration section, select the **Machine Type** to which the prediction applies.
9. Under **Model**, select **Upload PMML File** to upload a PMML `xml` file that contains your exported trained model. Alternatively, select **Use Existing PMML File** to use a previously uploaded PMML file.

   For example, you may have completed external training using libraries like PySpark pipeline or R pipeline, and exported the trained model to a PMML file.

   You can only use training models supported by PMML4S (PMML Scoring Library for Scala), such as the neural network. For a list of supported model types in PMML4s, see https://www.pmml4s.org/#model-types-support.
10. Map the PMML model parameters to your machine type sensor attributes and metrics (KPIs).

The default mapping is performed for you. Verify and change any mappings to match the attributes in your PMML file.



11. Under **Forecast Window**, select one of the options:
    - **1 Hour Ahead**: Select this option to create a prediction for the next one hour.
    - **24 Hours Ahead**: Select this option to create a prediction for the next 24 hours.
    - **7 Days Ahead**: Select this option to create a prediction for the next 7 days.
    - **30 Days Ahead**: Select this option to create a prediction for the next 30 days.

    > **Note:**
    >
    > The options that appear depends upon the data life span settings for your device data and metric data. These settings can be managed under **Menu > Settings > Storage Management**.

12. Select a **Reporting Frequency** for the prediction.

    For example, if you choose a **Forecast Window** of **24 Hours Ahead** and a **Reporting Frequency** equal to **Hourly**, then the prediction for 24 hours ahead is made every hour.

13. Click **Save** to save the prediction.

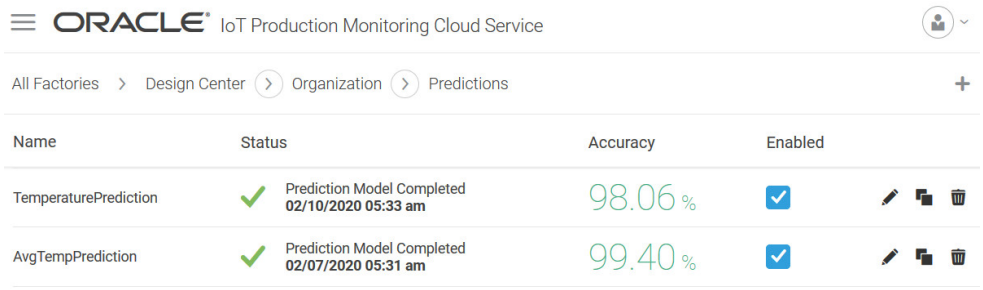
Edit a Prediction

Edit a prediction to change the prediction settings. You can also tweak your prediction model to add or remove features, and re-train the prediction model for your environment.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Predictions** .

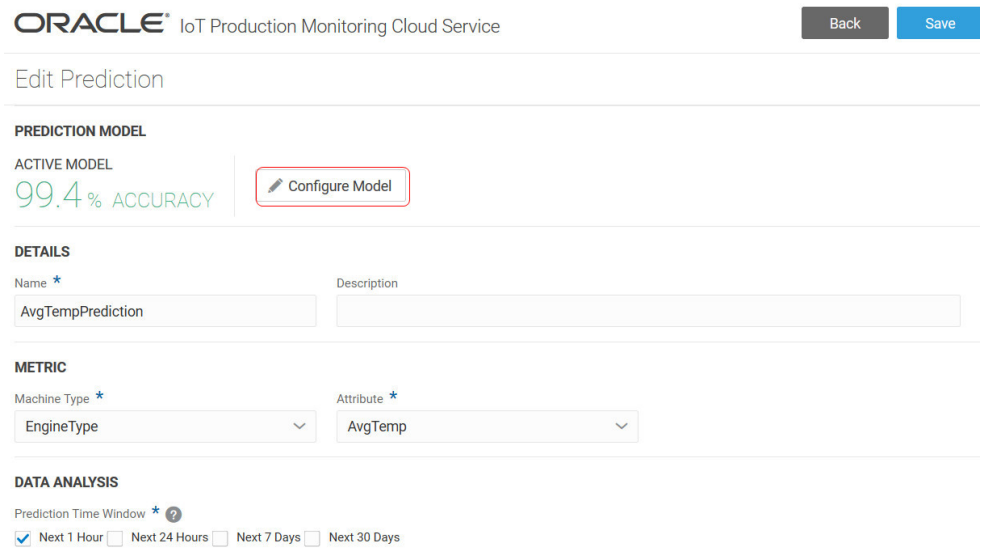
If the initial training for the prediction has completed, you should see an accuracy percentage for the prediction. The accuracy percentage reflects the scoring accuracy history of your prediction model measured against actual data.

Here's a sample Predictions page:



4. Click **Edit** ( ) against the prediction that you wish to edit.
5. (Optional) Under Prediction Model, click **Configure Model** if you wish to re-configure the current prediction model for your prediction.

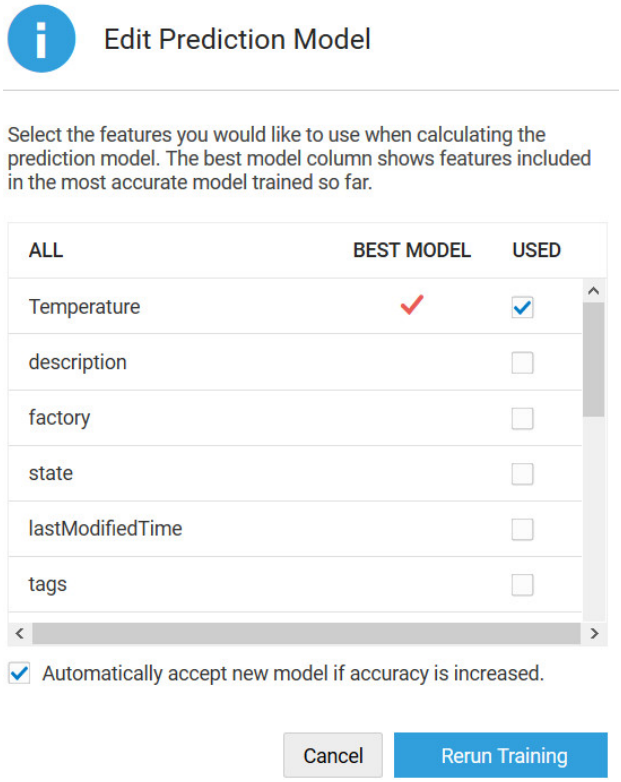
> **Note:**
>
> The Prediction Model section and the **Configure Model** options are available only for metric-based predictions, and not for direct sensor-based predictions.



This setting is available if the training for your prediction has completed, and a scoring accuracy is available. You can add or remove features or attributes currently associated with your prediction to select a feature-set that you believe is most relevant for your environment and will result in better scoring accuracy. Your changed feature-set is then used to re-train the prediction model. You may also

wish to re-train the prediction model if golden data has arrived post the initial training of the prediction.

a. Select or deselect features, or attributes, as required under the Used column.



If an attribute shows selected under the Best Model column, it means that the attribute is part of the best prediction model to date.

b. Select **Automatically accept new model if accuracy is increased** to automatically switch the active model to your new model if the scoring accuracy is better.

If you do not select this option, then after the training is complete, you can see both the currently active model and new model scores. You can then choose to switch to the new prediction model if you wish.

c. Click **Rerun Training** to re-train the prediction with the chosen features and cumulative data.

Clicking **Cancel** discards your changes.

6. Edit other prediction settings on the Edit Prediction page, as required.
7. Click **Save**.

Use Contextual Data Connections

Contextual data connections let you access factory and machine related data from database tables. You can use a Database Classic Cloud Service instance to store your data. You can also use an Autonomous Transaction Processing database table.

You may have contextual data stored in external systems, such as supply chain planning or maintenance systems, and you may want to use this contextual data feed in the Production Monitoring application to define metrics and perform analytics.

Create a Contextual Data Connection to an Oracle Autonomous Transaction Processing Instance

Create a contextual data connection to link to an Autonomous Transaction Processing database table. You can use the data in the table for metric computations and analytics.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Contextual Data** .
4. Click **Add** .
5. Enter a **Name** and an optional **Description** for the contextual data connection.
6. Under Data Format, select **ATP** as the database **Type**.
7. Enter the name of your ATP database table in the **Table Name** field.
8. Click **Choose File** to select the wallet file required to connect to your ATP instance.

   Oracle client credentials (wallet files) are downloaded from ATP by a service administrator. If you are not an ATP administrator, your administrator should provide you with the client credentials.

   The wallet file for the ATP database can be downloaded from the ATP service console.
9. Enter the **Connection String** to use for the Autonomous Transaction Processing instance.

   For example, a simple connection string would look like the following:

   ```
   database_host[:port][/[service_name]
   ```
10. Enter the user name for connecting to the Autonomous Transaction Processing database in the **User Name** field.
11. Enter the password for the user in the **Password** field.
12. If you are creating a new table, then under the **Fields** section, click **Create New** ( ) to add a table column.

    Specify a **Name** and **Type** (data type) for each table column that you add. Select **Primary Key** when adding the primary key column.
13. Under **Associations**, you can associate the ATP table fields with their corresponding sensor attributes.
    a. Click **Add** and select a **Name** for the association.
    b. Under **From**, select a machine type.

c. Select a sensor attribute from the list of sensor attributes available for the machine type.

d. Under **To**, select the corresponding ATP table column.

e. Add additional sensor attributes to column associations, as required.

14. Click **Save** to create the contextual data connection.

Create a Contextual Data Connection to a Database Classic Cloud Service Instance

Create a contextual data connection to link to a Database Classic Cloud Service table. You can use the data in the table for KPI computations and predictive analytics.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Contextual Data** .
4. Click **Add** .
5. Enter a **Name** and an optional **Description** for the contextual data connection.
6. Select **DBaaS** in the **Type** list.
7. Enter the name of a table in the **Table Name** field.
   - Select **Table already exists** if the table is already present in the DBaaS database.
8. Enter the URL for the Database Classic Cloud Service instance in the **Connection String** field.
9. Enter the user name for the Database Classic Cloud Service instance in the **User Name** field.
10. Enter the password for the Database Classic Cloud Service instance in the **Password** field.
11. If you are creating a new table, then under the **Fields** section, click **Add** ( ) to add a table column.

    Specify a **Name** and **Type** (data type) for each table column that you add. Select **Primary Key** when adding the primary key column.
12. Under **Associations**, associate the DBaaS table fields with their corresponding machine type attributes.

    a. Click **Add** to create a new association.

    b. Enter a **Name** for the association.

    c. Under **From,** select a machine type and a machine type attribute.

    d. Under **To,** select the corresponding DBaaS table column or field.

    e. Click **OK.**

    f. Add additional associations, as required.
13. Click **Save** to create the contextual data connection.

Use Maintenance Schedule Optimizations

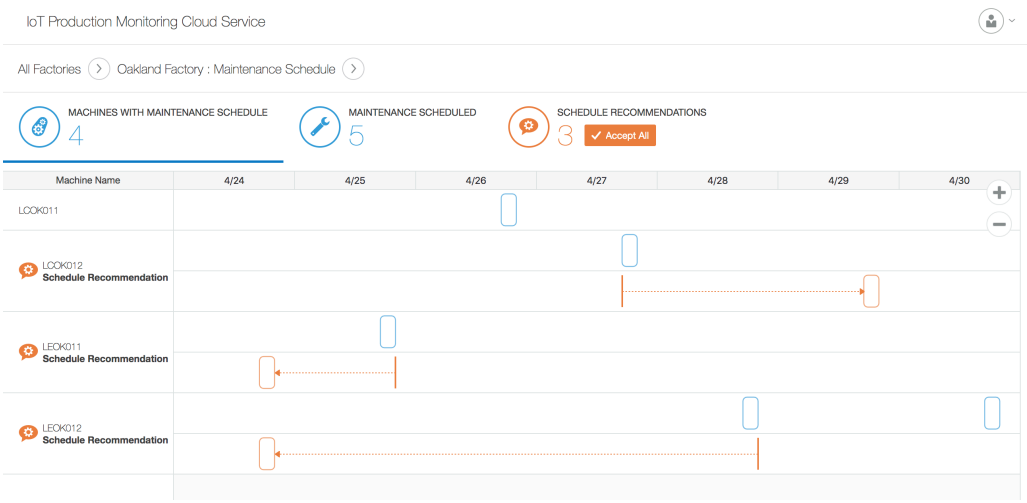
Oracle IoT Production Monitoring Cloud Service helps recommend an optimal preventive maintenance schedule that addresses high probability machine failures while minimizing product delivery delinquencies.

When you choose machine types for maintenance schedule optimizations, the system creates automatic failure predictions for the selected machine types, and uses this as an input when deciding on the optimum maintenance schedule for the machines. The automatic system predictions created by Oracle IoT Production Monitoring Cloud Service appear on the Predictions page.

Enhanced maintenance schedule optimization suggestions prioritize minimizing overall delinquencies over individual machine failures. So, for example, if you have multiple machines with high failure probabilities, the maintenance schedule optimization first works on minimizing overall delinquencies. It then focuses on reducing product delinquencies attributable to individual machines.

The Factory view includes the **Maintenance Schedule** tab where you can view the currently uploaded maintenance schedule and optimization suggestions.

In the following example, Oracle IoT Production Monitoring Cloud Service suggests pushing out the maintenance schedule for the first machine and pulling in the maintenance schedule for the other two machines, so as to reduce overall product delinquencies for the Oakland factory.



> **Note:**
>
> The factory must already have a production plan and maintenance schedule in place. See Understand Production and Maintenance Data and Upload Production and Maintenance Data for more information on uploading production and maintenance data.
>
> The system makes maintenance recommendations after analyzing the uploaded production data, such as production plan and product routing, and the maintenance schedule.

Maintenance recommendations for an individual machine are created after factoring in the machine's probability of failure and the production cost, or delinquency, associated with each day. A machine is marked as *High/Medium/Low* failure machine based on its probability of failure. For machines that do not have a failure probability value, no recommendations are provided.

The maintenance schedule optimization for individual machines uses the following logic:

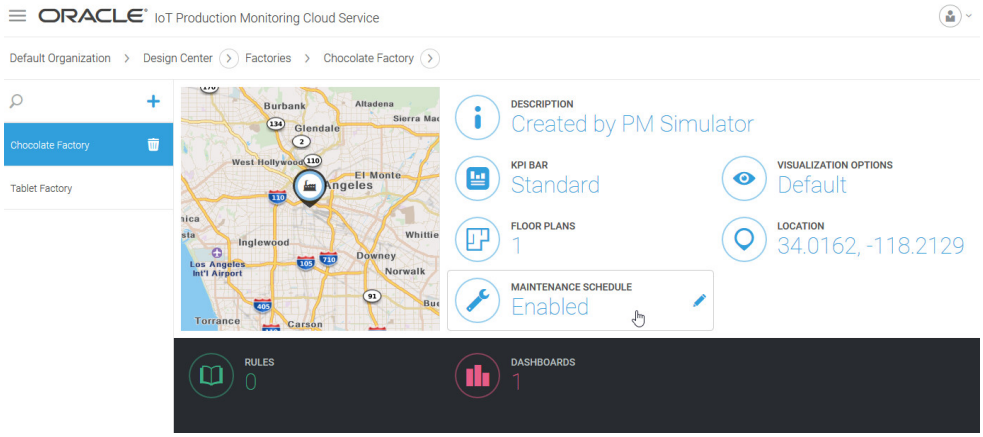
- For high failure probability machines with a failure probability percentage above 70%, the earliest two possible maintenance days are found, and the day with the lowest cost is recommended.
- For medium failure probability machines with a failure probability percentage between 25% and 70%, the application tries to retain the originally scheduled day after rescheduling the high failure machines. If this day is not available then the system chooses the previous day or next day, depending upon the lowest cost. If these days are not available, then the application chooses the next closest day with the lowest cost.
- For low failure probability machines with a failure probability percentage between 25% and 70%, the application looks for the furthest possible days and chooses the one with the lowest associated cost.

Configure the Factory Maintenance Settings

You can edit maintenance settings, such as selecting the machine types for maintenance optimization, from the Factory settings page.

When you choose machine types for maintenance schedule optimizations, the system creates automatic failure predictions for the selected machine types, and uses this as an input when deciding on the optimum maintenance schedule for the machines. The automatic system predictions created by Oracle IoT Production Monitoring Cloud Service appear on the Predictions page.

1. Click **Menu** ☰ and then click **Design Center**.
2. Click **Factory** 🏭 from the **Design Center** menu..
3. Select the factory, and click **Maintenance Schedule** in the right pane.



You are directly taken to the **Maintenance Schedule** tab for the selected factory.

4. Select **Enable Maintenance Schedule** to enable the maintenance schedule for the factory.
5. Under **Machine Types,** add the machine types for maintenance schedule optimizations.

   Oracle IoT Production Monitoring Cloud Service creates automatic failure predictions for each machine type that you select.
6. Under **Analysis Timeframe,** select the number of days that the Oracle IoT Production Monitoring Cloud Service server looks into the future to analyze maintenance schedule optimizations.
7. Under **Maintenance Capacity,** enter the maximum number of machines that can be put under maintenance for each day of the week.
8. Click **Save** to save your settings.

View and Optimize the Maintenance Schedule

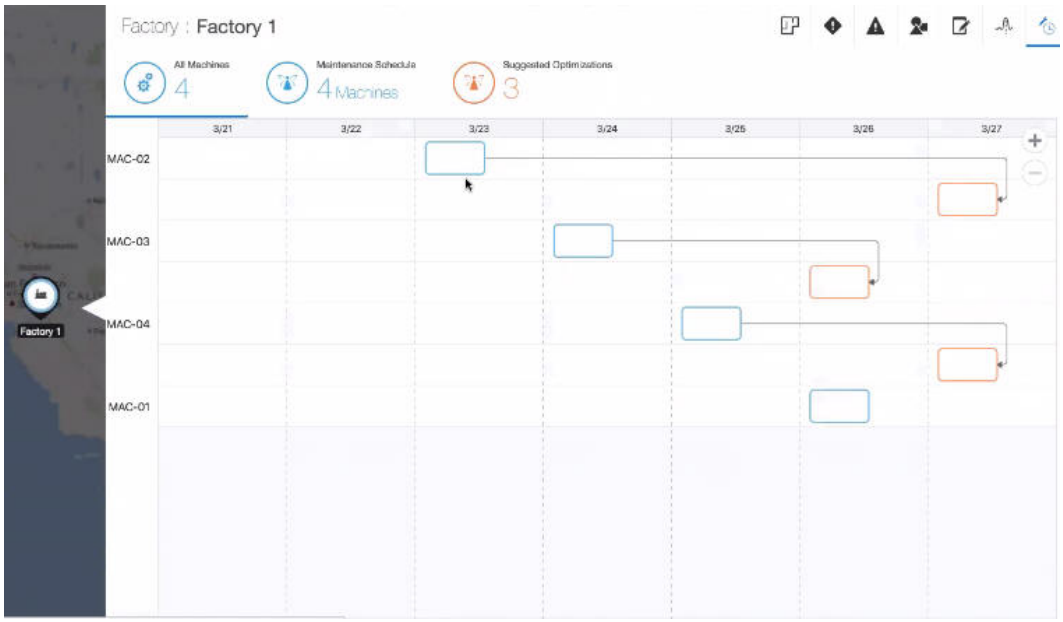
Use the **Maintenance Schedule** tab of the Factory view to look at, and to optimize, the maintenance schedules for the various machines in a factory.

> **Note:**
>
> You can upload the maintenance schedule form the **Uploads** page in **Menu > Design Center > Organization > Uploads.**

Locate your factory in the Map view. You might need to zoom in or out, and click to expand clusters of factories until you find your factory. Then click your **Factory** icon to access the Factory view.

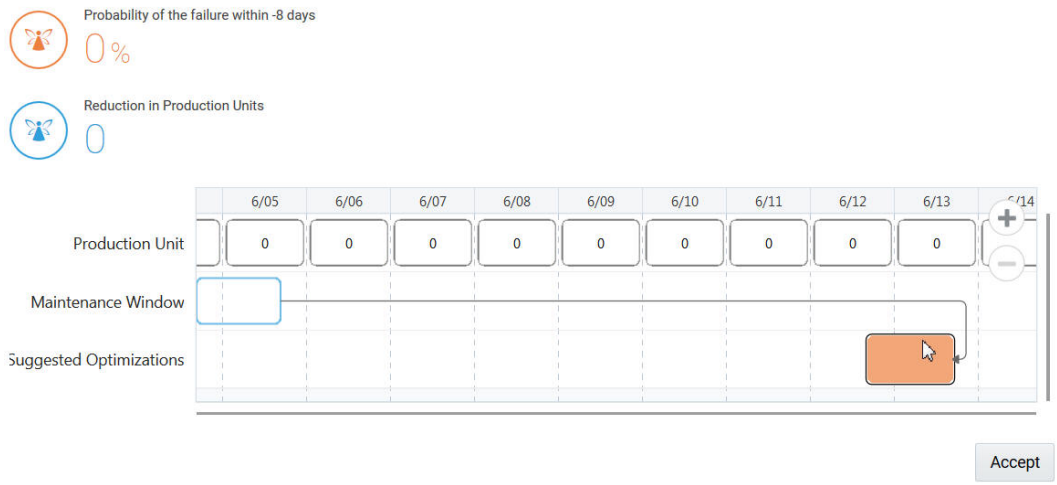
1. In the Factory view, click the **Maintenance Schedule** tab.

A Gantt chart displays the current maintenance schedule for the various machines in the factory. The suggested optimizations, or alternate dates, also appear for the machines. The current maintenance schedule appears as blue boxes, and the suggested schedule appears in orange.



2. Click **Zoom In** or **Zoom Out** to adjust the view.
3. Click the maintenance schedule box (blue or orange) for a machine to view its details.

   Details such as the probability of failure and the difference in production units between the current and recommended schedule for the machine are shown.
4. To accept a recommendation, click on the suggested recommendation (Orange box), and click **Accept.**



Use Statistical Trends for Machine Attributes

You can create statistical trends for your machine attributes using one or more Nelson Rules. These may help you analyze the consistency and predictability of your attribute values.

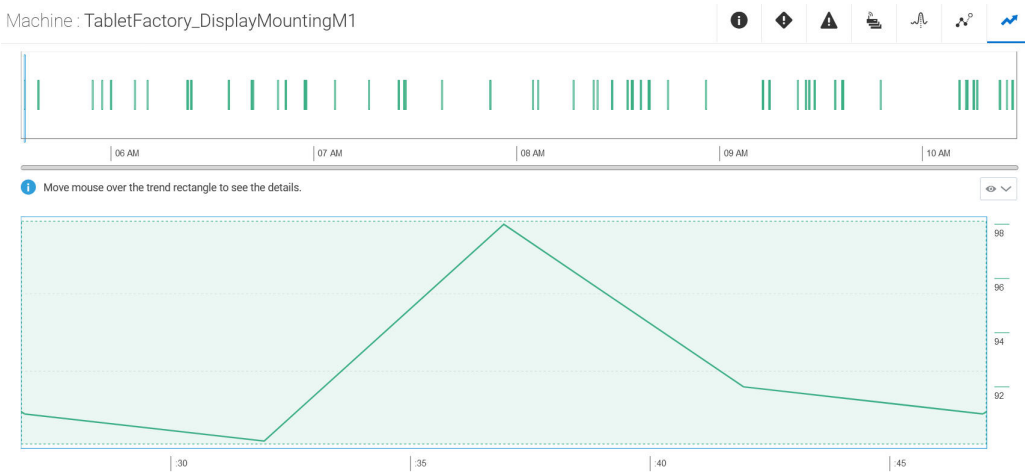
Trends use a set of Nelson Rules along with your machine type and attribute to be analyzed. For example, you may wish to analyze the trends for the pressure, temperature, or vibration sensor values of your machine. You can choose one or more of the following Nelson Rules that are relevant for your machine attribute:

- Nelson Rule 1: One point is more than three standard deviations from the mean.
- Nelson Rule 2: Nine, or more, points in a row are on the same side of the mean.
- Nelson Rule 3: Six, or more, points in a row are continuously increasing or decreasing.
- Nelson Rule 4: Fourteen or more points in a row alternate in direction, increasing then decreasing.
- Nelson Rule 5: Two or three points in a row are more than two standard deviations from the mean in the same direction.
- Nelson Rule 6: Four, or five, out of five points in a row are more than one standard deviation from the mean in the same direction.
- Nelson Rule 7: Fifteen points in a row are all within one standard deviation of the mean on either side of the mean.
- Nelson Rule 8: Eight points in a row exist, but none within one standard deviation of the mean, and the points are in both directions from the mean.

View Trends

Trends are available in the corresponding machine view of the machine attribute.

In the **Floor Plan** view, or in the **Production** view for a factory, click the icon for the machine you want to monitor. Then select the **Trends** tab to look at the machine attribute trends.



Define a Trend

You need to define a trend before the trend model can be created for the machine attribute that you wish to monitor.

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Trends**.
4. Click **Add** .
5. Enter a name for the trend in the **Name** field.
6. (Optional) Specify an optional **Description** text for the trend.
7. (Optional) Under Configuration, select a value under **Keep Metric Data For**.

   If you have unique storage requirements for historical data related to this trend, you can select an option that is different from the global settings defined under **Storage Management** on the application Settings page.

   For example, if you are calculating trends across a large number of machines, and the trends data is not required beyond a month, then you can select **30 Days** under **Keep Metric Data For** to optimize storage.
8. Under Configuration, select the **Machine Type** for your trend.

   The trend applies to all machines of the chosen machine type.
9. Select the corresponding machine **Attribute** to monitor.
10. Select a value for **Detection**:
    - **Automatic:** Automatically chooses trends corresponding to all available Nelson Rules.
    - **Select Specific Trends:** Lets you select one or more individual Nelson Rules that are relevant for your machine attribute.
11. If you chose **Select Specific Trends** in the previous step, then select one or more Nelson Rules for your Trends.

    The description and graphical depiction of each rule are shown for you.
12. Under Training, select the **Data Window**.

    The **Data Window** identifies the data set that is used to train the system for trend detection.
    - **Static**: Uses a static data window to train your trend model. If you have golden data from a period when your machine worked normally, you can use the same to specify a static window. Select the **Window Start Time** and **Window End Time** for your static window period.
      The static data window provides data for a one-time training of your trend model. If your definition of normal data changes in the future, you should edit the **Data Window** for the trend, so that the model can be re-trained.

- **Rolling**: A rolling data window uses data from a rolling time window to pick the most recent data for training. For example, you can choose to train your trend model with a rolling data window of the last 7 days, and choose to perform the trend training daily.
  When you use a rolling window, the training model is re-created periodically, as determined by the schedule frequency that you choose.
  - **Rolling Window Duration**: The duration of the rolling window going back from the model training time. For example, if you select **7 Days**, then the last 7 days of specimen machine data is used to train the trend model.
  - **Schedule**: The frequency of the trend model training. For example, if you choose **Daily**, then the training happens every day at 00:00 hours (midnight), UTC time by default.

13. Click **Save** to save the trend definition.

8

Use the Mobile App

Use the mobile app to view and update incidents while working on machine maintenance. You can also locate a machine on the map and view the sensor data for the machine that you are repairing.

If you have an in-place integration with Oracle Fusion Cloud Manufacturing, then an operator can use the mobile app to view and update work orders assigned to the currently logged-in operator.

Topics

- View and Update Incidents in the Mobile App
- View the Sensor Data in the Mobile App
- Locate a Machine
- View and Update Work Orders in the Mobile App
- Log Out of the Mobile App

View and Update Incidents in the Mobile App

Use the mobile app to view and update an incident while you are on the field repairing or maintaining machines.

- Tap an incident from the **Incident** list or use the**Search** to search for a specific incident.

  The **Info** tab is selected by default.

- To update the state, tap **State** and then tap ⌄ to select a state from the list.

  By default, the state is set to **New**. After you modify the state, you cannot change it back to **New**.

  The available states are: **Open**, **Work In Progress**, and **Withdrawn**.

- To update the priority, tap **Priority** and then tap ⌄ to select a priority from the list.

  The available priorities are: **High**, **Medium**, and **Low**.

- Tap **Comments** tab to view or add comments to this incident.

View the Sensor Data in the Mobile App

View the sensor data for a specific machine on the mobile app to diagnose the issue that generated the incident that you are trying to resolve.

1. Tap an incident from the **Incident** list or use the **Search** field to search for a specific incident.

   The **Info** tab is selected by default.

2. On the **Info** page, tap the **Machine** name.
3. From the tab bar, tap **Sensors** .
4. (Optional) Tap **Filters** and then define a criteria to filter the sensor data:
   - **Time Period**: Select live to view the real-time data, or choose to view the data for the last day, last week, or last month.
   - **Sensor**: Select one of the available sensors for this machine.
   - **Attributes**: Select one or more attributes to monitor for the selected sensor.
5. (Optional) From **Additional Info** select one or more options to contextualize the sensor data:
   - **Behind Plan**
   - **State Changes**
   - **Products Manufactured**
6. Tap **Down** located next to **Filters**, to close the filter options panel.

Locate a Machine

Locate the machine for a certain incident in the mobile app while you are working on machine maintenance on the field.

1. Tap an incident in the **Incident** list or use the **Search** field to search for a specific incident.
2. On the **Info** page, tap the **Machine** name.
3. From the tab bar, tap **Map** .

The floor plan map for this factory appears. The machine involved in this incident is signaled on the map with a **Machine** icon.

View and Update Work Orders in the Mobile App

If you have an in-place integration with Oracle Fusion Cloud Manufacturing, then an operator can use the mobile app to view and update work orders assigned to the currently logged-in operator.

1. Tap **Menu** and then tap **Work Orders**.

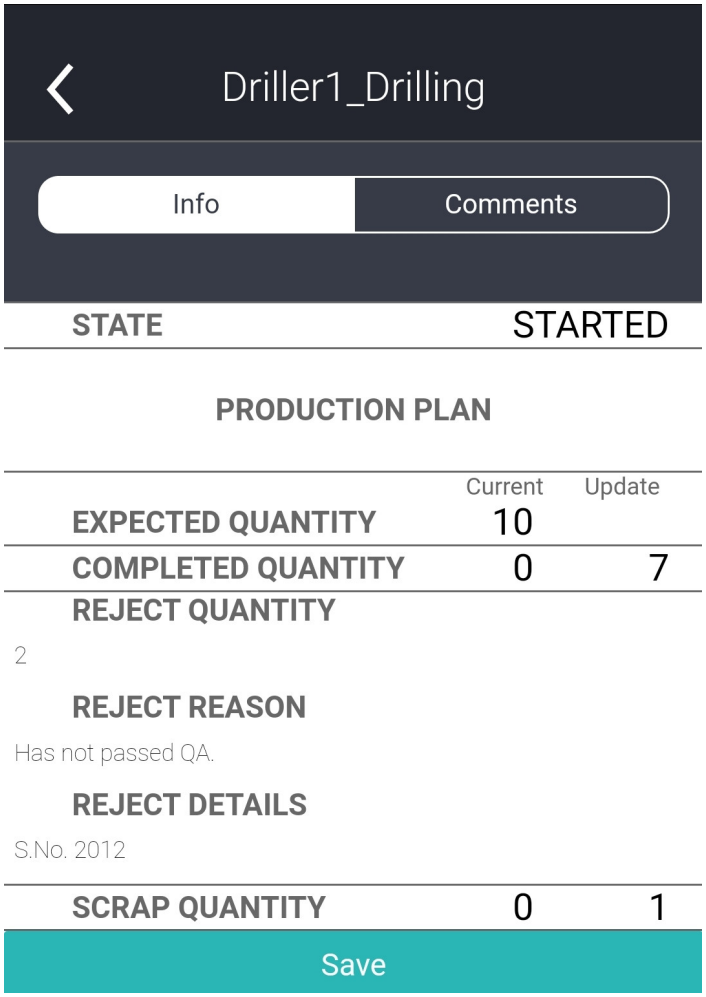
   Only work orders currently assigned to the operator are shown.
2. Tap a work order from the **Work Orders** list, or use **Search** to search for a specific work order.

   The routing tasks associated with the work order appear.
3. Tap a routing task from the **Routing Tasks** list.

   The **Info** tab is selected by default.

4. To update the state of the routing task, tap **State** and then tap to select a state from the list.

   For example, select **Started** to start a routing task.
   Depending on the production plan, you may be able to update and save data, such as completed quantities, reject quantities, and scrap quantities. The work order status and production output quantities are synced with Oracle Fusion Cloud Manufacturing at periodic intervals.



5. Tap the **Comments** tab to view or add comments for this routing task.

Log Out of the Mobile App

Log out of the mobile application after you finish your work..

1. Tap **Menu** and then tap **About** .
2. Tap **Sign Out**.

Part II

Configure Oracle Internet of Things Production Monitoring Cloud Service

This part contains the following chapters:

- Customize Your Application
- Integrate with Other Cloud Services
- Simulate Factory Operation
- Upload Your Data
- Configure Your Devices

9

Customize Your Application

Customize the appearance of the web application. You can also define new metrics.

Topics

- How to Customize Your Application
- Customize the Application Branding
- Customize Existing Metrics
- Monitor Data Storage and Manage Capacity Usage
- Use External Storage Options for Long-Term Data Availability and Analysis

How to Customize Your Application

Customize your application to use a different logo, change the color and organization of the metrics, or add new metrics.

You can customize your applications in the following ways:

- Customize the branding area: Change the logo or hide it. You can also hide the application name. See Customize the Application Branding.
- Customize existing metrics: You can change the order of your metrics, change the colors used to display their value, and add new groups organize them. See Customize Existing Metrics.
- Define your own metrics: You can define new metrics to monitor key values for your factory. See Define Your Own Metrics.

Customize the Application Branding

Show or hide the application name when business requirements change. Add or update corporate logos when business requirements change or a new corporate logo is issued.

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** () before you see the **Settings** option in the menu.

   > **Note:**
   >
   > If you wish to change the appearance for an individual organization only, navigate to **Menu > Settings > IoT Organizations > *Organization Name***.

2. Click **Appearance** on the Settings page.
3. Select one of these options:.

a. Select **Show Application Name** to display the application name on all application pages.

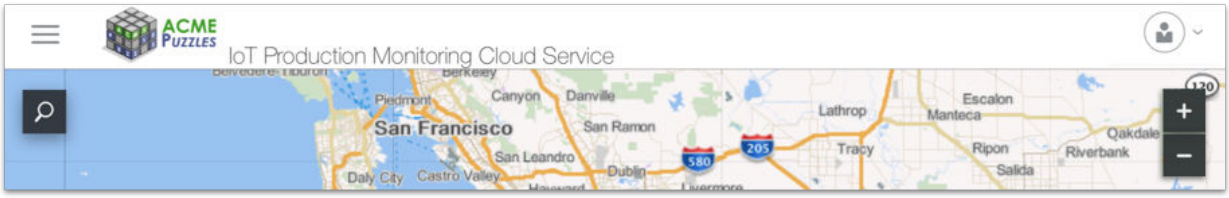
b. Clear **Show Application Name** to remove the application name from all application pages.

4. Under **Title Bar Logo**, select **Custom**.

   Under Image, click the **Drag and Drop** area to select an image file to upload. Alternatively, you can also drag and drop the image file to the **Drag and Drop** area in your browser window.

5. Click **Save**.

This image shows the title bar using a custom logo for ACME Puzzles.



Set Default Units of Measure

Set the default units of measurement for your application. You can select between the US Imperial and Metric unit systems.

1. In the Operations Center, click **Menu** (☰), and then click **Settings**.

   If you are in the Design Center, you need to click **Previous** (❮) before you see the **Settings** option in the menu.

> **Note:**
>
> If you wish to change the measurement units for an individual organization only, navigate to **Menu > Settings > IoT Organizations > *Organization Name***. For example, you may want to set different measurement units for your US and Europe organizations.

2. Click **Units and Measurement**.

3. Click **Edit** to change the unit system.

4. Under **Unit System**, select between **US Imperial** and **Metric**.

   The US Imperial setting uses the following units for *Distance*, *Speed*, *Temperature*, and *Volume* respectively: *Miles*, *Miles per Hour*, *Fahrenheit*, and *Gallons*.

   The Metric setting uses the following units for *Distance*, *Speed*, *Temperature*, and *Volume* respectively: *Kilometers*, *Kilometers per Hour*, *Celsius*, and *Liter*.

5. Click **Save**.

Use Third-Party Map Providers

Oracle IoT Intelligent Applications let you integrate with third-party map providers. You can customize your Map page to use the maps and search facility included by your map provider. When you select a third-party map provider, the built-in maps get replaced with the maps provided by your map provider.

You can also choose to override the map provider for an individual organization from the organization settings.

To use a third-party map provider:

1. In the Operations Center, click **Menu** (☰) and choose **Settings** .

   > **Note:**
   >
   > If you wish to change the map provider for an individual organization only, navigate to **Menu > Settings > IoT Organizations > *Organization Name***.

2. Click **Map Provider**.
3. Select a map provider.

   We currently support **HERE Maps**, as a third-party map provider.
4. Select one of the time options in the **Refresh Time** list. This determines the time interval at which the map data is refreshed in the application.

   If you select **Custom**, enter the number of seconds in **Value**.
5. If you selected HERE Maps, complete these fields:

   > **Note:**
   >
   > - From 22.4.1 release onward, Oracle recommends that you configure HERE maps using OAuth mechanism. In other words, instead of using HERE maps login credentials, generate an access token for authenticating to HERE maps. And to generate the access token, you must first generate OAuth credentials (access key ID and access key secret) as described in the HERE Developer portal at https://developer.here.com.
   > - The **Application ID** and **Application Code** fields are displayed only if you have previously configured HERE maps.

   - **Application ID**: Enter your HERE Technologies application ID.
   - **Application Code**: Enter your HERE Technologies application code.
   - **Access Key ID**: This is the access key credential used for authenticating to HERE maps using OAuth mechanism. Generate and enter the access key from the https://developer.here.com website.

- **Access Key Secret**: This is the secret credential used for authenticating to HERE maps using OAuth mechanism. Generate and enter the access key secret from the https://developer.here.com website.
- **Access Token URL**: Accept the default value or enter the access token URL. The access token URL defines the API used to generate access tokens for authenticating to HERE maps using OAuth mechanism.
- **Base URL**: Accept the default value or enter the base URL. The base URL defines the API used to render the map tiles.
- **Route URL**: Accept the default value or enter the route URL. A route URL defines the API used to determine the route to be covered by a trip or shipment in map view.
- **Geocode URL**: Accept the default value or enter the geocode URL. The geocode URL defines the API used to convert a human-readable address into geographic coordinates.
- **Reverse Geocode URL**: Accept the default value or enter the reverse geocode URL. A reverse geocode URL defines the API used to convert geographic coordinates into a human-readable address.
- **Batch Reverse Geocode URL**: Accept the default value or enter the batch reverse geocode URL. A batch reverse geocode URL defines the API used to convert multiple geographic coordinates into human-readable addresses.
- **Aerial URL**: To display satellite imagery in the map view, accept the default value or enter the aerial URL An aerial URL defines the API used to display satellite imagery.
- **Traffic URL**: To display real-time traffic data in the map view, accept the default value or enter the traffic URL A traffic URL defines the API used to display traffic data.
- **Map Tiles Language**: Select the language in which you want the map tiles to be displayed in map view. Note that map tiles for a selected language is displayed only if the corresponding language data is available in HERE maps. If HERE maps doesn't have the corresponding language map tile, then it defaults to displaying the map tiles in English.

6. Click **Validate Credentials**. After you receive a success message, click **Save** and close the window to return to the Settings page.

The Map page now starts using maps from your specified map provider in place of the built-in maps. With HERE Maps, you can choose to display the satellite or terrain view as well. Choose from amongst the following options on the map:

- **Classic**
- **Satellite**
- **Terrain**
- **Traffic**

The option to see points of interest is also available in all the HERE Maps layers.

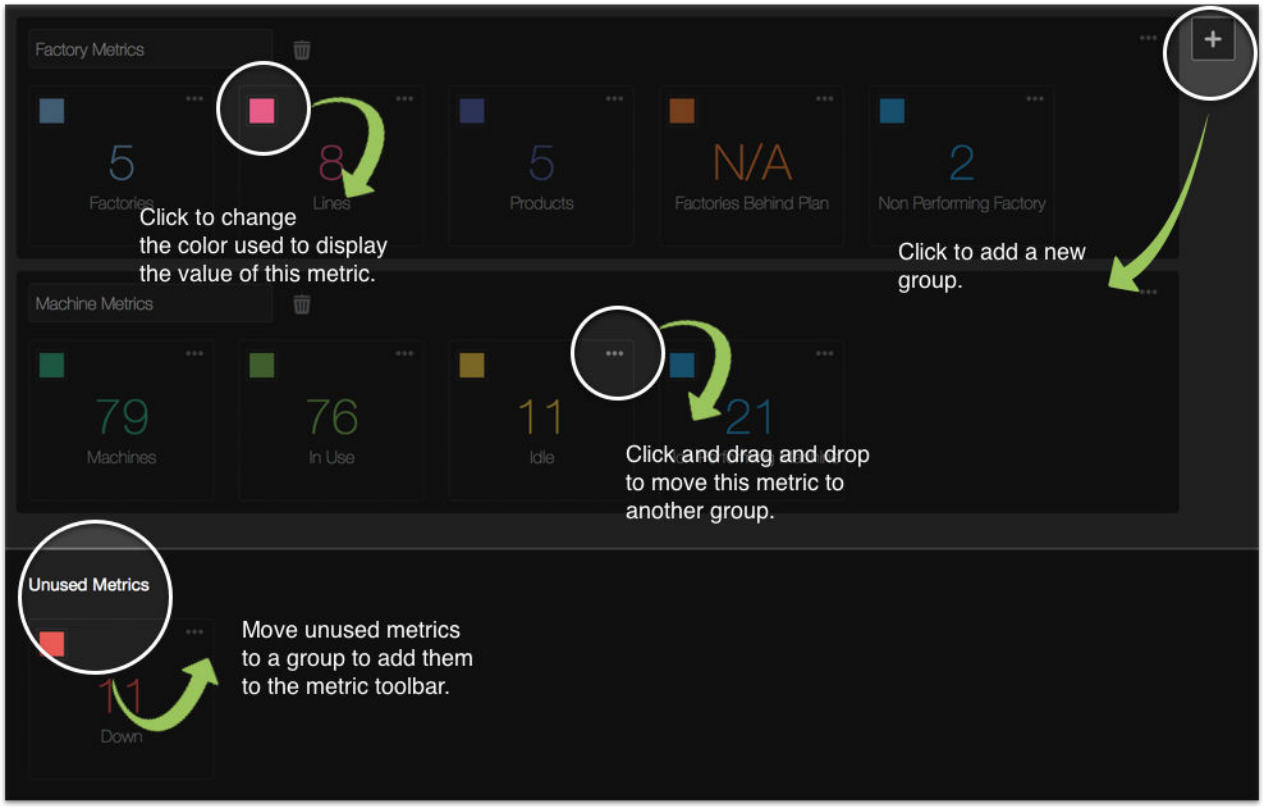
If you wish to revert to using the built-in Oracle maps, you can choose **Oracle Maps** from the Map Provider page.

Customize Existing Metrics

Customize the metrics in the Map and Factory views to use an order and colors that are meaningful to you. You can also add new groups to organize your metrics.

1. In the **Map** view or **Factory** view, click **Edit** located in the **Metrics** toolbar.
2. Customize the **Metrics** toolbar in the following ways:
   - Click the color swatch to change the color used to display the value of a metric.
   - Click **Add** to add a new group.
   - Click **...** and drag and drop the metric to a different location in the same group, or to another group.

   This image shows you how to customize the **Metrics** toolbar:



3. Click **Save**.

Monitor Data Storage and Manage Capacity Usage

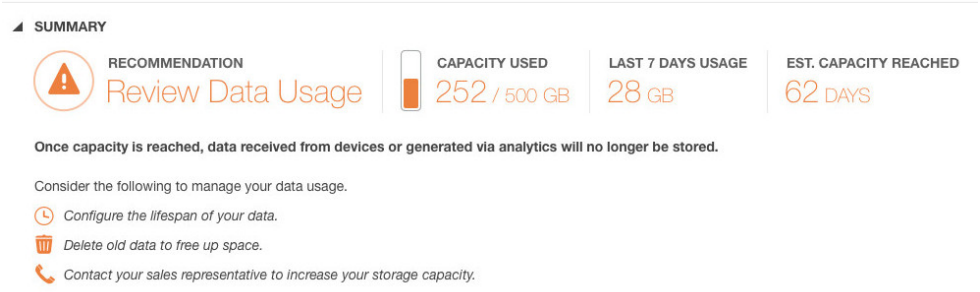
As an administrator, you can monitor the data storage for your Oracle IoT Intelligent Applications Cloud Service. Use the Storage Management page to review storage data in the system, to set up or adjust the time window for data retention, and to run data deletion jobs.

> **Note:**
>
> If you are using more than one application in Oracle IoT Intelligent Applications Cloud Service, then the data storage settings are shared between these applications. Also, any operations that you perform under data management, such as tweaking data life spans or creating deletion jobs, affects data in all these applications.
>
> So, for example, if you are using the Asset Monitoring and Production Monitoring applications, the data usage includes usage across both these applications. Also, if you were to delete metric data older than, say, 30 days, then metric data that is older than 30 days is deleted in both your applications.

When you log in to your IoT application as an administrator, a notification appears with details on the storage capacity used. Notifications may also appear periodically for every 10% of capacity that is used up. High-priority notifications are sent after you have used up more than half of the storage capacity. You can use the Storage Management page to manage your storage capacity.

The **Storage Management** tile under application **Settings** lets you monitor and manage the data storage for your application. The Storage Management page has the following sections:

- **Summary:** Shows you the total data storage capacity available for your account, and the currently used up capacity. Depending on your current usage, the status is indicated using one of the following colors:
  - **Green:** Indicates that more than 50% of the available capacity remains.
  - **Orange:** Indicates that between 25% and 50% of the available capacity remains. A recommendation on ways to manage your data is also included.
  - **Red:** Indicates that less than 25% of the available capacity remains, and you must take steps to manage your storage data.



- **Data Management:** Lets you manage data, change settings, and create data deletion jobs. The data capacity usage percentages are shown category-wise:
  - **Raw Device Data:** Raw time-series data from devices that is stored in a normalized JSON format. Comprises application messages, connector messages, integration-related messages, log messages, and other related messages.

Oracle recommends a data life span of 7 Days, or less, for this category to avoid high storage consumption.

- **Sensor Data:** Time-series data from devices and computed attributes used for machine-learning models and anomaly detection. Comprises incoming sensor data, visualization and training data.
  Set the data life span for this category to match your business requirements for data retention.
- **Custom Metric Data:** Computed values of user-defined metrics. Comprises data specific to custom metrics or KPIs. Custom metrics are metrics that you create in the application for your production environment and scenarios.
  Set the data life span for this category to match your business requirements for data retention.
- **System Metric Data:** Computed values of built-in system metrics that are automatically computed. Comprises data specific to system metrics or KPIs. System metrics are the built-in metrics that are calculated automatically in your application.
  Oracle recommends a data life span of 90 Days, or less, for this category to avoid high storage consumption.
- **System Event Data:** System notifications about background activity, such as software version upgrade, storage capacity change, analytic computation failure, or integration sync issues.
  Oracle recommends a data life span of 30 Days, or less, for this category to avoid high storage consumption.
- **Transaction Log Data:** Comprises logs related to all shipment transactions that have occurred between Oracle IoT Fleet Monitoring Cloud and OTM or ITT.
  Set the data life span for this category to match your business requirements for data retention.

You can select the data life span for each category. The data life span is the time period for which data is retained. If you set the data life span for a category to **Delete Manually**, then data for that category is never deleted, unless you manually run a data deletion job. Note that this setting may potentially lead to storage capacity issues, as stored data is never deleted.

You can choose to create data deletion jobs to delete selective data. A data deletion job lets you select the data type and time span for which you wish to delete data.

Perform Data Management Tasks

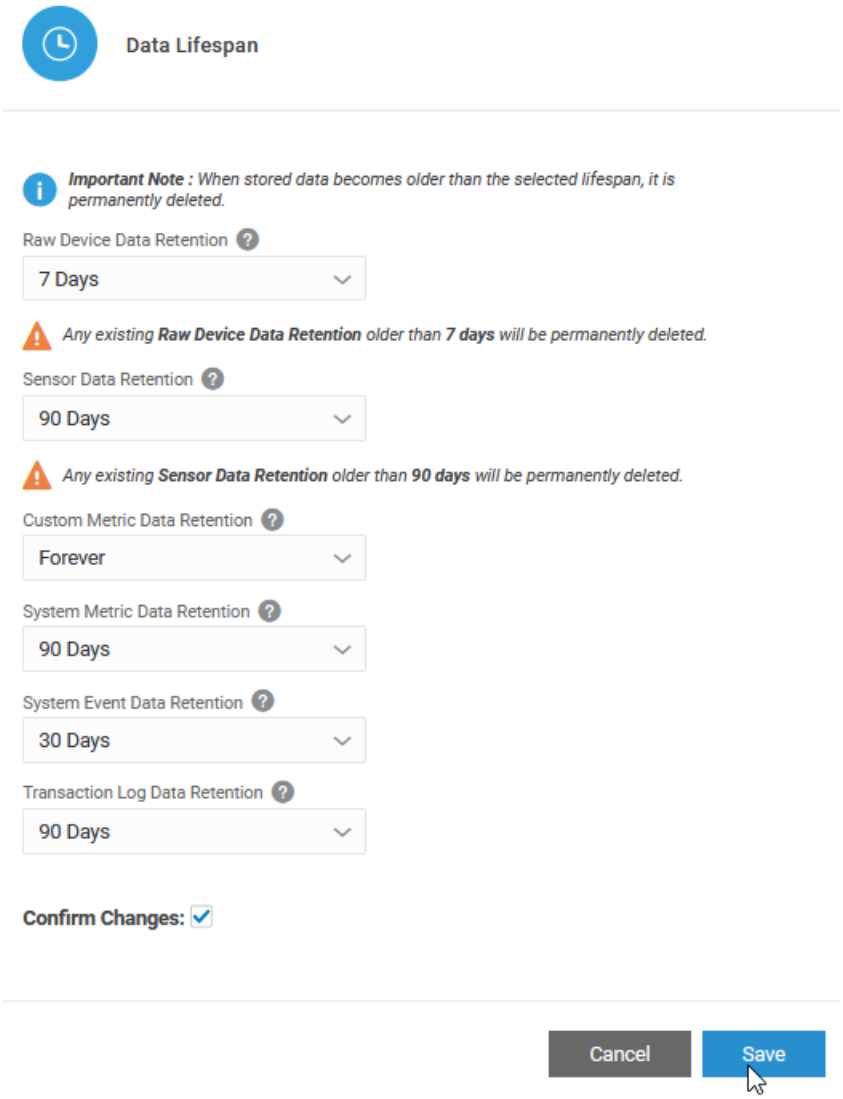
Use the **Data Management** section to manage data storage settings for your application. You can select the data life span for the various data types. You can also create data deletion jobs to delete selective data.

1. Click **Menu** (☰) and then click **Settings** .
2. Click **Storage Management**.

   The Storage Management page appears.
3. To change the data life span, click **Edit** ✎ under **Data Life Span**.

   The Data Life Span section appears under the Data Management section.

   a. Select the data life span for **Raw Device Data**, **Sensor Data**, **Custom Metric Data**, **System Metric Data**, and **Transaction Log Data**.



If you select **Forever** for a category, then the data for that category is never deleted automatically. You would need to run a data deletion job, described in the subsequent steps, to select and delete any data for the category.

b. Select **Confirm Changes** and click **Save** to save your settings.

4. (Optional) To run a data deletion job, click the **Create Data Deletion Job** button.

   a. In the Create Data Deletion Job dialog box, select one or more data types for which you wish to delete data.

      The available choices are:

      - **Device**
      - **System Metrics and Custom Metrics**
      - **Sensor**

   b. Under **Delete Data**, choose the time period for which you wish to delete the data.

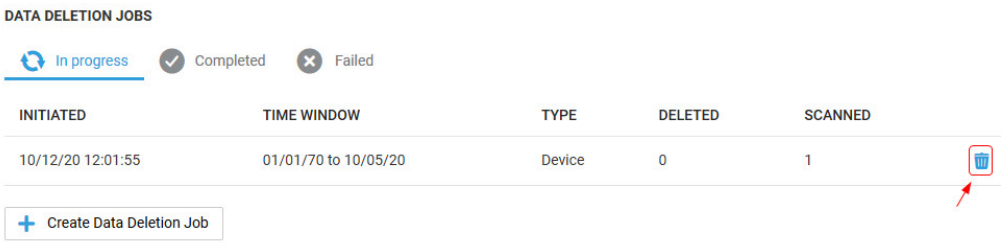
      For example, you may want to delete sensor data that is **Older than 30 days**.

You can also choose a custom **Time Range** for which to delete data. For example, you may wish to delete data for a particular day or hour.

c. Click **Delete** to create the delete job.

You can monitor the job progress, and the number of records that were deleted, under the Data Deletion Jobs section. When the data delete job completes, its status changes from **In Progress** to **Completed**.

You can also choose to delete a data deletion job. If the job is still running when you delete it, then the job is terminated and deleted. If the job has already failed or completed, then deleting the job simply removes it from the list of failed or completed jobs.



Use External Storage Options for Long-Term Data Availability and Analysis

You can choose to use one of the external storage options, namely Oracle Autonomous Database or OCI Object Storage, to safely and cost-effectively store your IoT sensor and analytics data for long-term persistence.

The application can use your external storage to store raw or aggregated sensor attribute data, and data related to analytics artifacts, such as metrics, anomalies, predictions, and trends. You can also store your rule incidents and warnings. You can use the historical data for visualization and analysis in external and third party applications.

You can use the rich querying functionality in Oracle Autonomous Database, or chart and analyze the stored data in external applications, such as Oracle Analytics Cloud. For example, you can use analyses, projects, and dashboards in Analytics Cloud to find the answers that you need from key IoT data displayed in graphical formats. You can use applications such as Oracle Visual Builder to create dashboards and mashups.

Use OCI Object Storage to Store Historical IoT Data

The Oracle Cloud Infrastructure (OCI) Object Storage service is an internet-scale, high-performance storage platform that offers reliable and cost-efficient data durability. If you have a subscription for OCI Object Storage, you can use it to store your IoT sensor and analytics data for long-term persistence.

You can learn more about OCI Object Storage here:

- Overview of Object Storage
- Get Started with Object Storage

Use the following steps to add and configure your external OCI Object Storage:

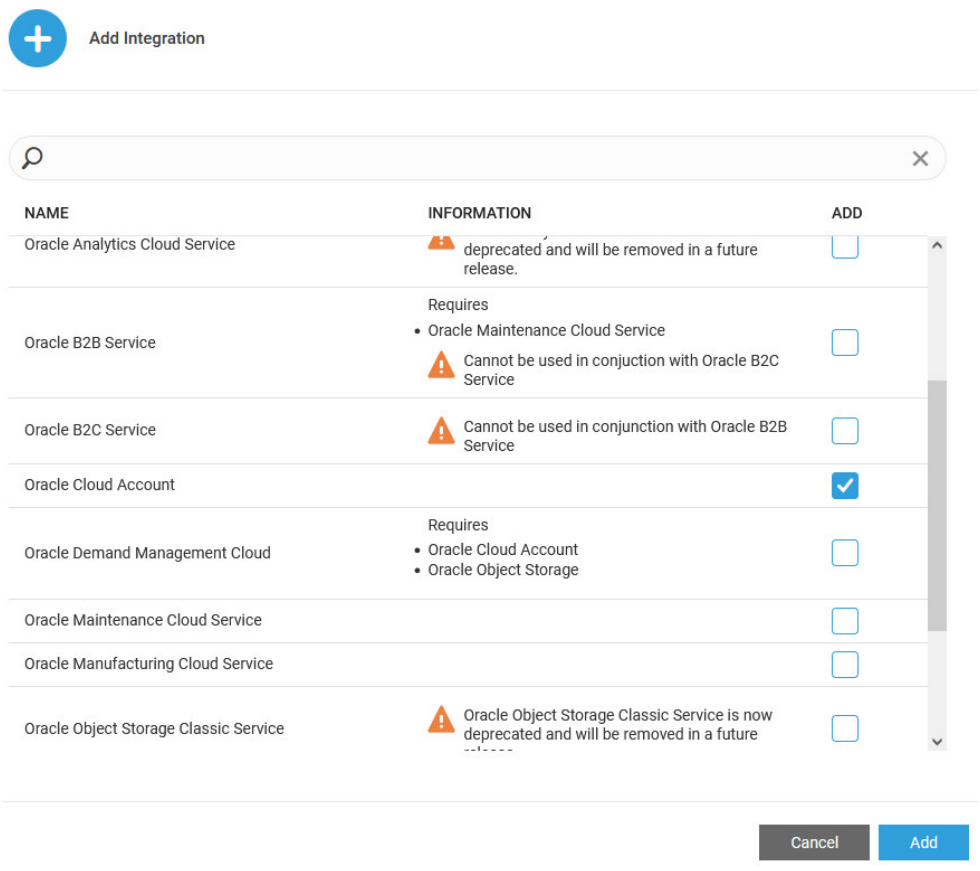
1. Add an Oracle Cloud Account
2. Connect to an OCI Object Storage Instance
3. Add and Configure Your External OCI Object Storage Integration

Add an Oracle Cloud Account

Use the **Settings > Integrations** page in your IoT application to configure an Oracle Cloud account. This Oracle Cloud account is used when specifying integration settings, such as OCI Object Storage settings.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **Oracle Cloud Account** and click **Add**.

   Tip: You can also search for an integration name in the list.

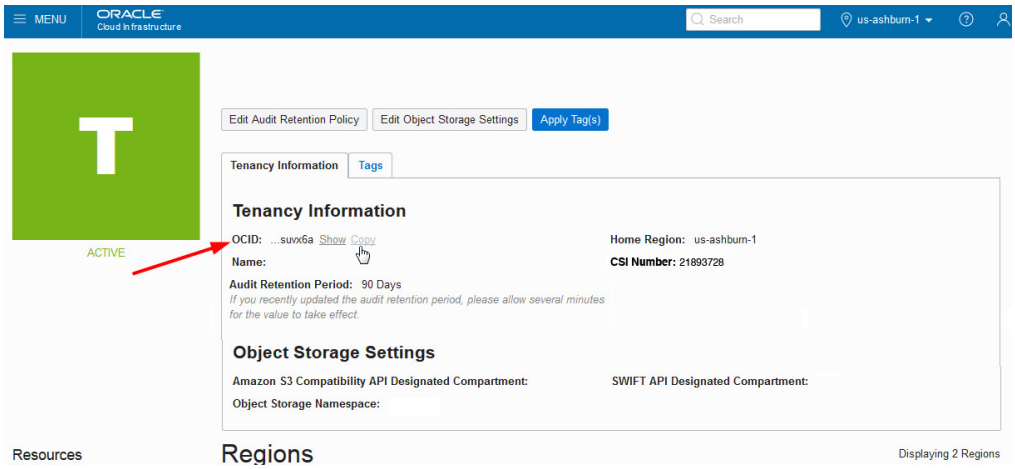


   Oracle Cloud Account integration gets added to the Integrations page.

5. Under **Oracle Cloud Account**, add your cloud account details:
   a. Enter your **Tenant OCID**.

The tenancy details are available from the Oracle Cloud Infrastructure Console. You need to log in to your Oracle Cloud Infrastructure Console. From the **Profile** menu, click **Tenancy: <YourTenancyName>**.

The tenancy OCID is shown under Tenancy Information. Click **Copy** to copy it to your clipboard.



Paste this value under **Tenant OCID** in your IoT application.

b. Enter the **User OCID**.

   The user details are available from the Oracle Cloud Infrastructure Console. You need to log in to your Oracle Cloud Infrastructure Console. From the **Profile** menu, click **User Settings**.

   The user OCID is shown under User Information. Click **Copy** to copy it to your clipboard.

   Paste this value under **User OCID** in your IoT application.

c. Under Public Key, click **Generate**.

d. Click **Close**.

6. Set the public key in OCI Object Storage.

   a. On the **Settings>Integration** page of your IoT application, under **Oracle Cloud Account**, click **Copy** against **Public Key** to copy the public key that you generated earlier.

   b. Log in to your Oracle Cloud Infrastructure Console.

   c. Under the **Profile** menu, click **User Settings**.

   d. Click **API Keys** under **Resources**.

   e. Click **Add Public Key**.

      Note: If three public keys are already listed under API Keys, you have to first delete one public key. An OCI Object Storage service user can't have more than three public keys.

   f. Select **Paste Public Keys** and paste the key that you copied from your IoT application.

   g. Click **Add**.

The fingerprint for the added public key appears under API Keys. The fingerprint should be the same as that displayed on the Settings page of your IoT application.

Connect to an OCI Object Storage Instance

Use the Integrations page in your IoT application to configure OCI Object Storage connection details and to enable Object Storage.

Before configuring the OCI Object Storage connection, you should have already added your Oracle Cloud account on the Settings page.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **Oracle Object Storage Service** and click **Add**.

   Tip: You can also search for an integration name in the list.

   Oracle Object Storage integration gets added to the Integrations page.
5. On the Integrations page, under Object Storage Service, click **Connect**.
6. In the Oracle Object Storage dialog, provide your object storage connection details.
   a. Enter the **Storage URL** for your OCI Object Storage.

      For example, `https://objectstorage.us-phoenix-1.oraclecloud.com`.
   b. Enter the object storage **Namespace** for your tenancy.

      You can find the object storage namespace in your Oracle Cloud Infrastructure Console. You need to log in to your Oracle Cloud Infrastructure Console. From the **Profile** menu, click **Tenancy: <YourTenancyName>**.
   c. Enter the **Default Bucket** name that stores the data.

      The bucket name must already exist in your OCI Object Storage instance.
   d. Click **Verify Connectivity** to verify the connection details and bucket name.
   e. Click **Save** to save the OCI Object Storage connection details.
7. To enable the connection on the Integrations page, click **Edit Configuration** under **Oracle Object Storage**.
8. Toggle the **Integration Status** switch to ON, and click **Save**.

Add and Configure Your External OCI Object Storage Integration

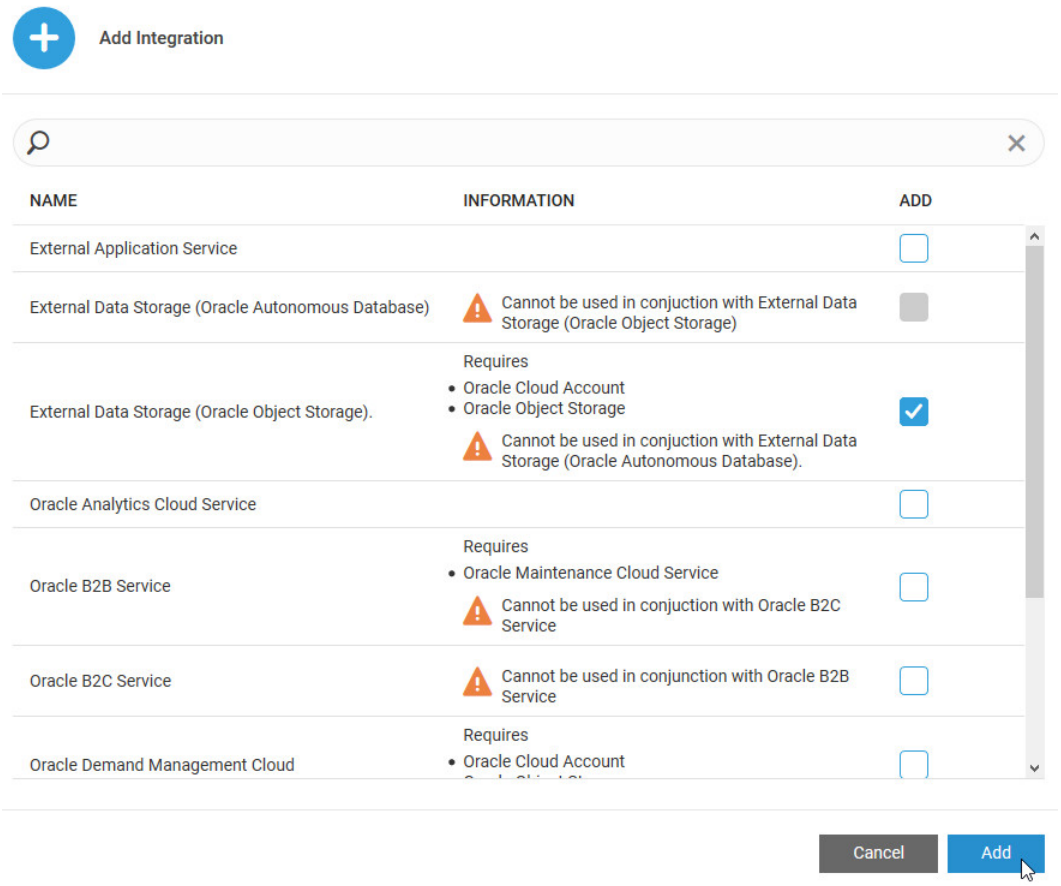
To start storing IoT historical data in your OCI Object Storage, add and configure a new integration for **External Data Storage (Oracle Object Storage)**.

> **Note:**
>
> You should have already added an Oracle Cloud account and specified the connection settings for your OCI Object Storage instance.

Video

1. In your IoT application, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **External Data Storage (Oracle Object Storage)** and click **Add**.

   Tip: You can also search for an integration name in the list.



> **Note:**
>
> You can only have one external data storage integration at a time. So, you cannot add both Oracle Autonomous Database and Oracle Object Storage integrations at the same time. If you need to switch from Oracle Autonomous Database integration to Oracle Object Storage, you should first remove the Oracle Autonomous Database integration from the Integrations page.

The **External Data Storage (Oracle Object Storage)** integration gets added to the Integrations page.

5. On the Integrations page, under **External Data Storage (Oracle Object Storage)**, click **Edit Configuration**.
   a. Optionally enter a **File Prefix**.

      Your IoT application prefixes the specified **File Prefix** to the file names that it stores in OCI Object Storage. This helps with easy identification of files.

   b. The **Default Bucket** is pre-populated with the bucket that you have used in your Object Storage connection settings.

   c. Optionally change the **Export Interval** if you want your application to write more frequently to OCI Object Storage.

      The default data export interval is **4 Hours**.

   d. Select the IoT data that you wish to store externally:

      - **Attributes:** You can choose to export all raw sensor attribute data. Alternatively, you can choose to export only aggregated attribute data, which exports aggregates, such as *Average*, *Maximum*, and *Minimum* values of your attribute values. Under **Attributes Granularity Level**, select **Aggregated** to export only aggregated attribute data. Under **Attributes Granularity Level Interval** , specify the aggregation interval. This determines the frequency at which the aggregated values are calculated.

        If you select **None (raw data)**, then all raw sensor data is exported.

      - **Metrics:** Select to export metric data corresponding to system metrics and computed metrics.
      - **Anomalies:** Select to export anomaly data.
      - **Predictions:** Select to export prediction data.
      - **Trends:** Select to export data related to trends.
      - **Incidents:** Select to export your rule incidents.
      - **Warnings:**Select to export your rule warnings.

   e. Toggle the **Integration Status** switch to **Enabled**.

6. Click **Save** to save your configuration settings.

Use Oracle Autonomous Database to Store Historical IoT Data

Oracle Autonomous Database runs on Oracle Cloud Infrastructure and provides workload-optimized cloud services for transaction processing and data warehousing. If

you have a subscription for Oracle Autonomous Database, you can use it to store your IoT sensor and analytics data for long-term persistence.

You can choose either an Oracle Autonomous Transaction Processing database , or an Oracle Autonomous Data Warehouse database to externally store your IoT data.

You can learn more about Oracle Autonomous Database options here:

- Oracle Autonomous Database Solutions
- Getting Started with Autonomous Transaction Processing
- Getting Started with Autonomous Data Warehouse

Use the following steps to add and configure your external Oracle Autonomous Database storage:

Video

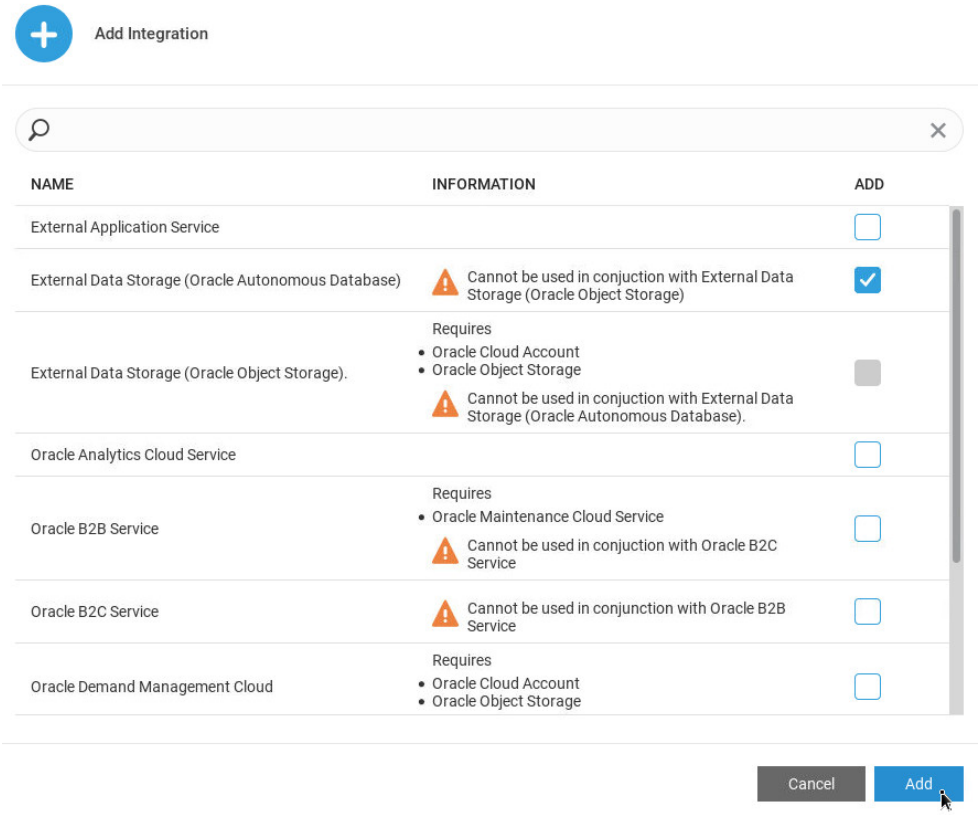
1. Add an Oracle Autonomous Database Integration
2. Enable and Configure the Oracle Autonomous Database Integration

Add an Oracle Autonomous Database Integration

To start storing IoT historical data in an Oracle Autonomous Database, add and configure a new integration for **External Data Storage (Oracle Autonomous Database)**.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **External Data Storage (Oracle Autonomous Database)** and click **Add**.

   Tip: You can also search for an integration name in the list.



> **Note:**
>
> You can only have one external data storage integration at a time. So, you cannot add both Oracle Autonomous Database and Oracle Object Storage integrations at the same time. If you need to switch from Oracle Object Storage integration to Oracle Autonomous Database, you should first remove the Oracle Object Storage integration from the Integrations page.

The **External Data Storage (Oracle Autonomous Database)** integration gets added to the Integrations page.

5. On the Integrations page, under **External Data Storage (Oracle Autonomous Database)**, click **Connect** to specify the connection details.

   a. In the External Data Storage Connection dialog, click **Upload Wallet Zip File** to upload the wallet required to securely connect to your database.

      Oracle client credentials (wallet files) are downloaded from Oracle Autonomous Database by a service administrator. If you are not the database administrator, your administrator should provide you with the client credentials. The wallet file for the ATP/ADW database can be downloaded from the ATP/ADW service console.

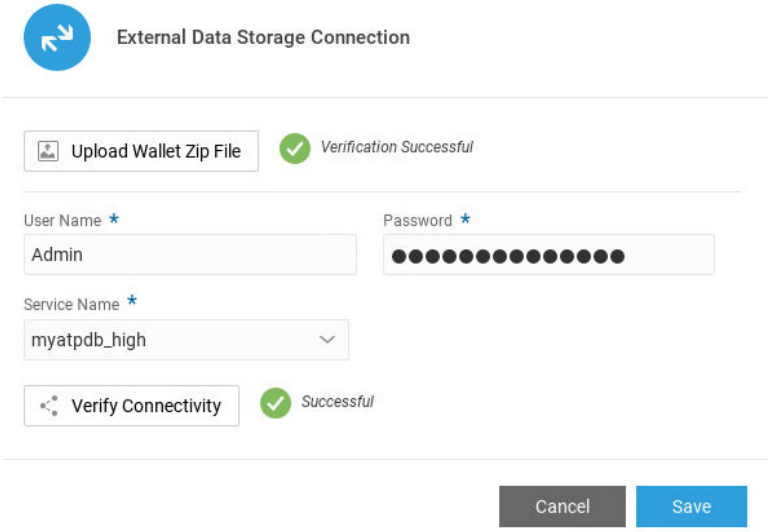
      After you upload the wallet file, the application verifies the wallet and prompts you for the database login credentials.

   b. Enter the **User Name** and **Password** used to log into the database.

c. Select the **Service Name** for the database.

   The list of service name options is retrieved from the wallet that you uploaded earlier.

d. Click **Verify Connectivity** to verify connectivity to your Oracle Autonomous Database instance.



   The **Save** button is enabled after successful verification of the connection credentials.

6. Click **Save** to save your Oracle Autonomous Database connection settings.

Enable and Configure the Oracle Autonomous Database Integration

To start storing IoT historical data in your Oracle Autonomous Database, enable and configure the integration for **External Data Storage (Oracle Autonomous Database)**.

1. In your IoT application, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Under **External Data Storage (Oracle Autonomous Database)**, click **Edit Configuration**.
   a. Optionally enter a **Table Prefix**.

      Your IoT application prefixes the specified **Table Prefix** to the table names that it creates in Oracle Autonomous Database. This helps with easy identification of tables.

   b. Optionally change the **Export Interval** if you want your application to write more frequently to Oracle Autonomous Database.

      The default data export interval is **4 Hours**.

   c. Select the IoT data that you wish to store externally:

      - **Attributes:** You can choose to export all raw sensor attribute data. Alternatively, you can choose to export only aggregated attribute data, which exports aggregates, such as *Average*, *Maximum*, and *Minimum* values of your attribute values. Under **Attributes Granularity Level**, select **Aggregated** to export only aggregated attribute data. Under **Attributes Granularity Level Interval** , specify

the aggregation interval. This determines the frequency at which the aggregated values are calculated.

If you select **None (raw data)**, then all raw sensor data is exported.

- **Metrics:** Select to export metric data corresponding to system metrics and computed metrics.
- **Anomalies:** Select to export anomaly data.
- **Predictions:** Select to export prediction data.
- **Trends:** Select to export data related to trends.
- **Incidents:** Select to export your rule incidents.
- **Warnings:**Select to export your rule warnings.

d. Toggle the **Integration Status** switch to **Enabled**.

4. Click **Save** to save your configuration settings.

Use Oracle Analytics Cloud to Chart and Analyze Externally Stored Data

You can chart and analyze the stored data in external applications, such as Oracle Analytics Cloud. For example, you can use analyses, projects, and dashboards in Analytics Cloud to find the answers that you need from key IoT data displayed in graphical formats.

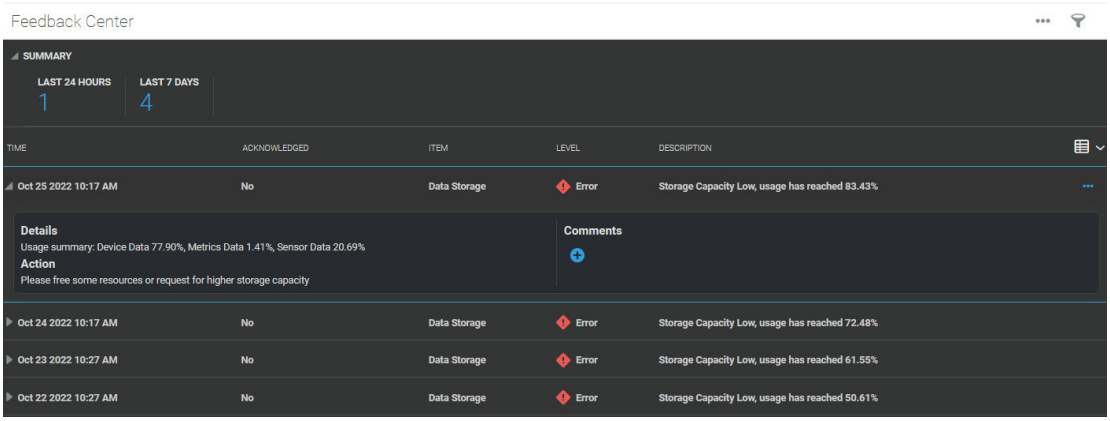
Video

The Feedback Center

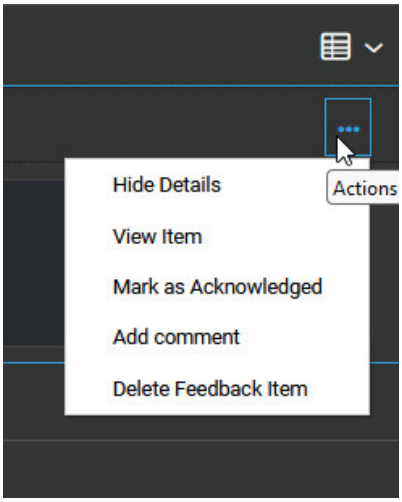
The Feedback Center notifies the administrator about system activity that may require administrator review and action.

For example, the system may need to notify you about storage capacity issues. Or the system may wish to report analytics issues, such as a metric computation being suspended, or a prediction-scoring failing two times in a row. The administrator can review the details for an event of interest, mark the issue as acknowledged, and choose to comment against the event with updates or remarks for other administrators.

When you first log in to the application, you are placed into the Operations Center for your organization. To access the Feedback Center, click **Menu** ☰, and then click **Feedback Center**.



Use the **Actions** menu against a feedback row to see the available options:



10

Integrate with Other Cloud Services

Oracle IoT Production Monitoring Cloud Service can integrate with other cloud services, such as Oracle Fusion Cloud Manufacturing.

Topics

- Integrate Oracle Fusion Cloud Manufacturing with Oracle IoT Production Monitoring Cloud Service
- Integrate Oracle Fusion Cloud Maintenance with Oracle IoT Production Monitoring Cloud Service
- Integrate with Oracle Analytics Cloud

Integrate Oracle Fusion Cloud Manufacturing with Oracle IoT Production Monitoring Cloud Service

You can import work orders from Oracle Fusion Cloud Manufacturing into Oracle Internet of Things (IoT) Production Monitoring Cloud Service. The application automatically updates the work order status and produced quantities in Oracle Fusion Cloud Manufacturing based on updates from the machine or operator.

In Oracle Fusion Cloud Manufacturing, a work order refers to a document that conveys the authority for the production of a specific product. It contains information about what, how, how many, and when to manufacture a product. The product item, work definition details, operations, resources, components, quantities, and dates are specified in the work order.

When configuring integration with Oracle Fusion Cloud Manufacturing, you can choose to create one-to-one mappings between the manufacturing organizations and your IoT organizations. If you choose one-to-one, the IoT server creates a separate IoT organization for each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing. If you choose many-to-one, then entities from each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing are imported into the selected organization in Oracle IoT Production Monitoring Cloud Service.

Oracle Fusion Cloud Manufacturing automatically synchronizes the factory entities with IoT for all manufacturing organizations that you enable in Oracle Fusion Cloud Manufacturing. Oracle IoT Production Monitoring Cloud Service no longer needs to pull these entities at regular intervals. The pull settings are deprecated and may be removed in a future release.

You can edit the work orders to assign resource instances (machines and operators) to the work orders in Oracle IoT Production Monitoring Cloud Service. These resource instances are then used for production and completion of the work order. Oracle IoT Production Monitoring Cloud Service automatically updates the work order status and produced quantities in Oracle Fusion Cloud Manufacturing based on updates from the machine or operator.

Add the IoT Application Integration Entry in Oracle Fusion Cloud Manufacturing

To begin integration with Oracle IoT Production Monitoring Cloud, add an application integration entry in Oracle Fusion Cloud Manufacturing with details to connect to your IoT application.

1. Log in to Oracle Fusion Cloud Manufacturing, as a user with the Application Implementation Consultant role.
2. In the Setup and Maintenance work area, click **Tasks** and click **Manage Setup Content**.
3. Click **Manage Integration of Additional Applications** in the Topology Definition section.
4. Click **Create** to create a new application integration.
5. On the Create Application Integration page, provide the following details under **Basic Information**:
   - **Application Name:** IoT Production Monitoring
   - **Full URL**: Use the following format:

     `https://hostname`

     Here, *hostname* is the host name of your Oracle IoT Production Monitoring Cloud Service instance.

     For example: `https://xyz.oraclecloud.com`
   - **Partner Name:** IoT Production Monitoring
   - **Security Policy**: Select `oracle/wss_http_token_over_ssl_client_policy`.
   - **User Name**: Specify the user name for connecting to your Oracle IoT Production Monitoring Cloud Service instance.
   - **Password**: Specify the password for connecting to your Oracle IoT Production Monitoring Cloud Service instance.

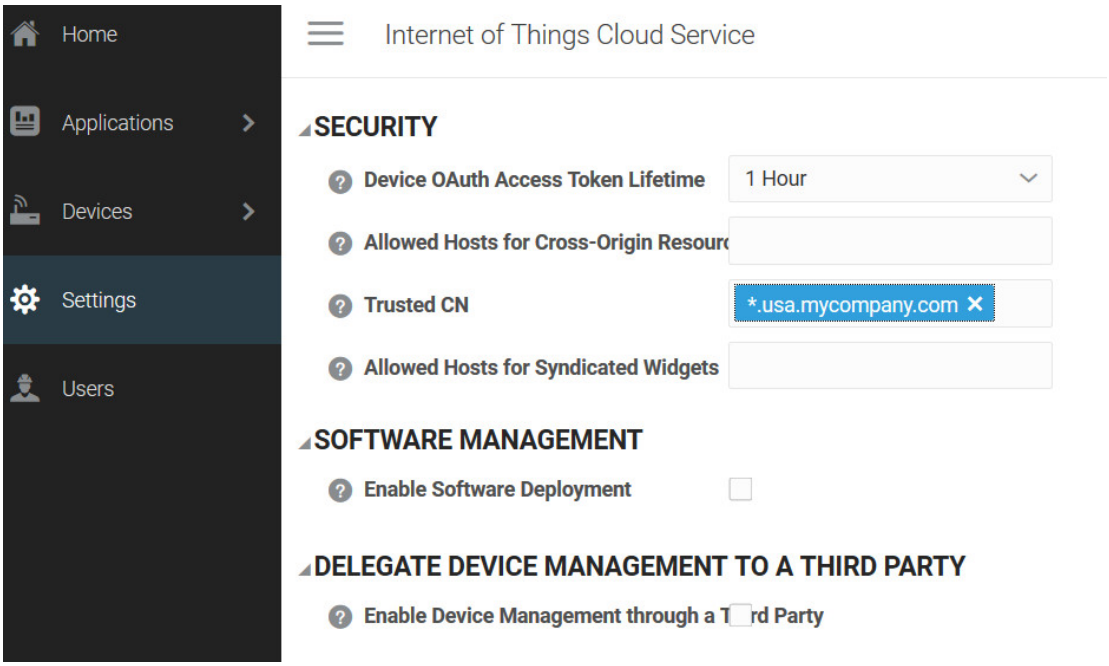
   > **Note:**
   >
   > If you change the password for connecting to your Oracle IoT Production Monitoring Cloud Service instance in future, then you must update the password in Oracle Fusion Cloud Manufacturing.
6. Click **Save and Close** to save the application integration entry.

Add an Oracle Fusion Cloud Manufacturing Integration

Use the Integrations page in Oracle Internet of Things (IoT) Production Monitoring Cloud Service to enable integration with Oracle Fusion Cloud Manufacturing.

Before you configure Oracle Fusion Cloud Manufacturing integration, make sure your Oracle Fusion Cloud Manufacturing host is trusted by your Oracle Internet of Things Intelligent Applications Cloud domain.

Host names with `.oraclecloud.com` and `.oraclecloudapps.com` suffixes are always allowed. If your Oracle Fusion Cloud Manufacturing domain name is different, then add the domain as a trusted CN in the Oracle Internet of Things Intelligent Applications Cloud management console. To do this, add `*.`*`YourDomain`*`.com` under **Trusted CN** in the Settings page.



You can access your Oracle Internet of Things Intelligent Applications Cloud management console at the following URL:

`https://`*`hostname`*`/ui`

Here, *`hostname`* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

To add an integration with Oracle Fusion Cloud Manufacturing:

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.

   You can access Oracle IoT Production Monitoring Cloud Service at the following URL:

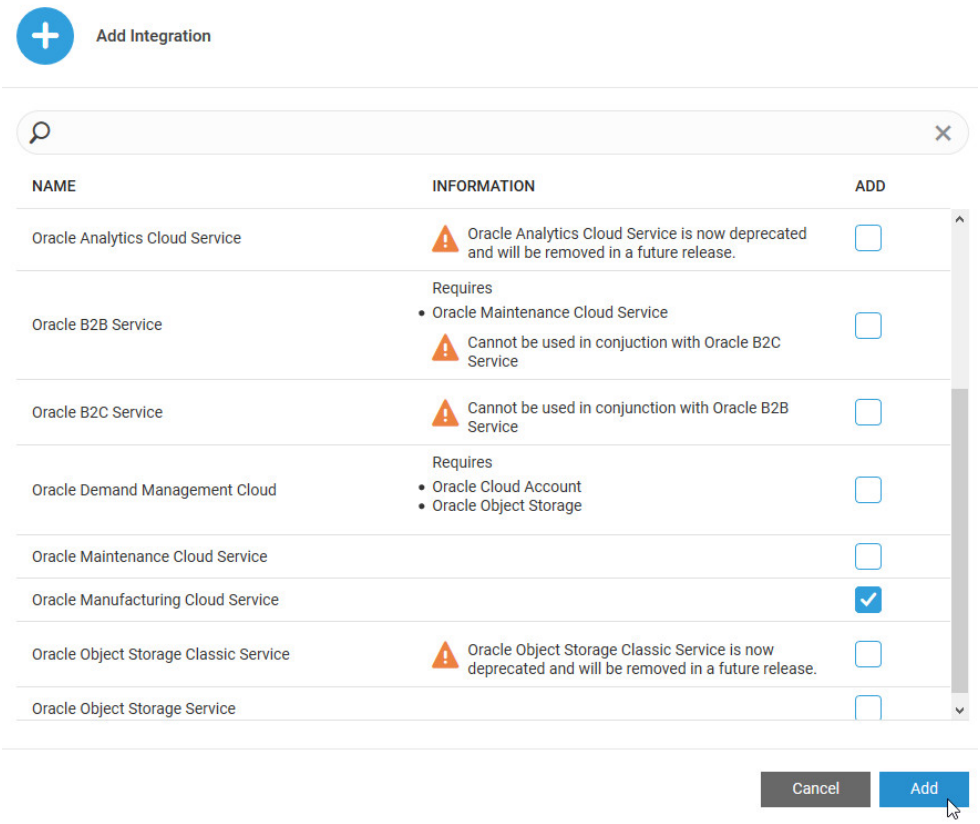
   `https://`*`hostname`*`/pm`

   Here, *`hostname`* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

   If you are in the Design Center, you need to click **Previous** (❮) before you see the **Settings** option in the menu.

2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **Oracle Manufacturing Cloud Service** and click **Add**.

   Tip: You can also search for an integration name in the list.



   Oracle Manufacturing Cloud Service integration gets added to the Integrations page.
5. On the Integrations page, under **Oracle Manufacturing Cloud Service**, click **Connect**.
6. Enter the **Service URL** for your Oracle Fusion Cloud Manufacturing instance.

   The endpoint URL should refer to the REST API URL for your Oracle Fusion Cloud Manufacturing instance. For example:

   ```
   https://servername.oraclecloud.com:443/fscmRestApi/resources/latest
   ```

   In the preceding example, `servername` is your cloud server instance.
7. Enter the **User Name** and **Password** for your Oracle Fusion Cloud Manufacturing instance.
8. Click **Verify Connectivity** to test your connection and credentials.
9. Click **Save** to save the connection settings.

10. On the Integrations page, under **Oracle Manufacturing Cloud Service**, select an appropriate value for **Oracle SCM Organizations Mapping**.
    - **One to One:** Lets you create one-to-one mappings between Oracle Fusion Cloud Manufacturing organizations and your IoT organizations. This helps separate the manufacturing organizations into their respective organizations in Oracle IoT Production Monitoring Cloud Service.

      If you choose One to One, the IoT server creates a separate IoT organization for each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing.
    - **Many to One:** Lets you choose one organization in Oracle IoT Production Monitoring Cloud Service where your Oracle Fusion Cloud Manufacturing factories are imported.

      If you choose Many to One, then entities from each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing are imported into the selected organization in Oracle IoT Production Monitoring Cloud Service.

Enable and Configure the Oracle Fusion Cloud Manufacturing Integration

To start using Oracle Fusion Cloud Manufacturing integration, enable and configure the integration for **Oracle Manufacturing Cloud Service** on the Integrations page.

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Under **Oracle Manufacturing Cloud Service**, click **Edit Configuration**.
4. Toggle the **Integration Status** switch to enable the connection.
5. Under **Enter Email**, specify the e-mail for an Oracle Fusion Cloud Manufacturing administrator.
6. Specify the desired **Outbound Synchronization** frequency in minutes.

   Outbound synchronization refers to work order updates, quantities, and other outbound updates from Oracle IoT Production Monitoring Cloud Service.
7. If you have upgraded from an older instance, and were already using Oracle Fusion Cloud Manufacturing integration, then you may see additional settings for organizations and inbound synchronization.
   a. (Optional) If you wish to import machines and work orders from specific organization(s), then specify the organization codes of the Oracle Fusion Cloud Manufacturing organizations under **Specific Organizations**.

      Press **Enter** after entering each organization code. If you leave this field empty, then work orders from all the organizations get sync'd by default.
      Each organization in Oracle Fusion Cloud Manufacturing translates into its own factory in Oracle IoT Production Monitoring Cloud Service. The name of the factory is the same as the organization name in Oracle Fusion Cloud Manufacturing.
   b. Specify the desired **Inbound Synchronization** frequency in minutes.

      Inbound synchronization refers to inbound work orders and data from Oracle Fusion Cloud Manufacturing.

   Starting with release 22.2.1, Oracle Fusion Cloud Manufacturing automatically syncs the factory entities with IoT for all manufacturing organizations that you enable in Oracle Fusion Cloud Manufacturing.

Oracle IoT Production Monitoring Cloud Service no longer needs to pull these entities at regular intervals. The pull settings are deprecated and would be removed in a future release.

Oracle recommends that you use the following steps to enable the push mode in Oracle Fusion Cloud Manufacturing:

a. Add the IoT Application Integration Entry in Oracle Fusion Cloud Manufacturing

b. Enable a Manufacturing Organization for IoT Synchronization

8. Click **Save** to save your configuration settings.

Enable a Manufacturing Organization for IoT Synchronization

When you enable a manufacturing organization to sync with IoT, Oracle Fusion Cloud Manufacturing creates the corresponding factory, along with its constituent entities, in Oracle IoT Production Monitoring Cloud Service. All subsequent updates to the factory are automatically pushed to Oracle IoT Production Monitoring Cloud Service.

1. Log in to Oracle Fusion Cloud Manufacturing.
2. In the Setup and Maintenance work area, click **Tasks** and click **Search**.
3. Search for the string, `"Manage Plant Parameters"`.

   Click the **Manage Plant Parameters** task returned in the search result.
4. Select the **Enable synchronization to IoT Production Monitoring** option.

   You can use **Change Organization** to change the current organization if you wish to enable IoT sync for a different organization.
5. Click **Save and Close** to enable IoT synchronization for the selected organization.

Understand Data Exchange with Oracle Fusion Cloud Manufacturing

After you configure the integration and enable one or more manufacturing organizations in Oracle Fusion Cloud Manufacturing to sync with IoT, Oracle Fusion Cloud Manufacturing automatically syncs the factory entities with IoT for the selected manufacturing organizations.

Oracle IoT Production Monitoring Cloud Service creates a factory corresponding to each manufacturing organization that is imported. The factory name is the same as the name of the manufacturing organization being imported.

If you choose one-to-one mapping, the IoT server creates a separate IoT organization for each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing. If you choose many-to-one mapping, then entities from each manufacturing organization that you enable in Oracle Fusion Cloud Manufacturing are imported into the selected organization in Oracle IoT Production Monitoring Cloud Service.

Data is imported into Oracle IoT Production Monitoring Cloud Service from Oracle Fusion Cloud Manufacturing. During the import process, Oracle IoT Production Monitoring Cloud Service converts Oracle Fusion Cloud Manufacturing resources to the following Oracle IoT Production Monitoring Cloud Service entities:

Oracle Fusion Cloud Manufacturing Resource	Oracle IoT Production Monitoring Cloud Service Entity
Manufacturing organization	Factory
Items	Products and product data
Work orders	Work orders and routing data
Resources and resource instances	Machine types and machines, operator types and operators

The machine types and operator types imported into Oracle IoT Production Monitoring Cloud Service have their respective Oracle Fusion Cloud Manufacturing organization codes suffixed to their names. So, if you have similarly named resources in two or more Oracle Fusion Cloud Manufacturing organizations, you can distinguish between these resources in Oracle IoT Production Monitoring Cloud Service using the org suffix in their names.

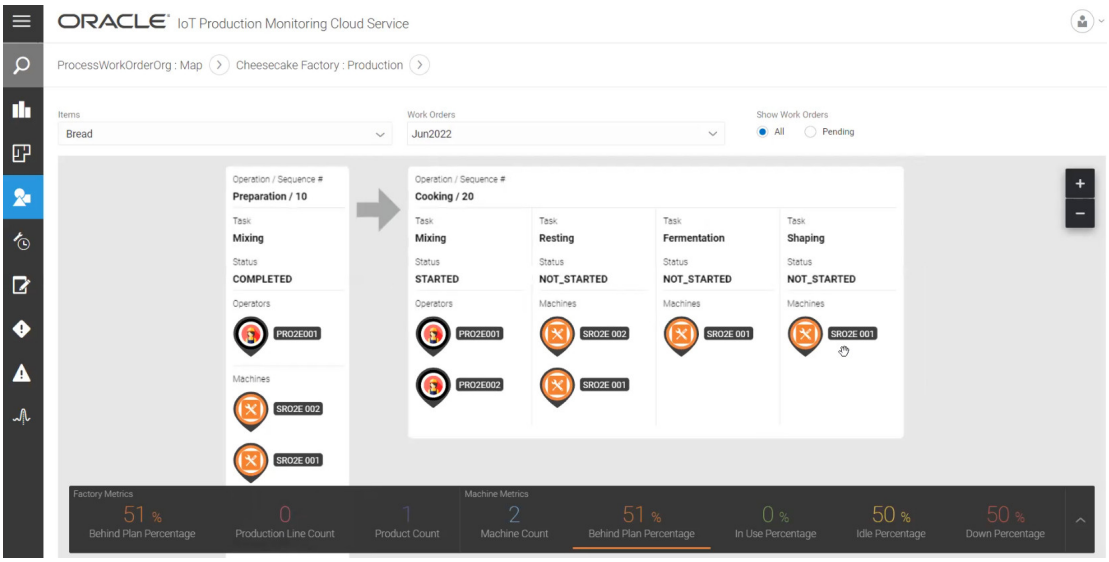
Edit the imported entities, as required in Oracle IoT Production Monitoring Cloud Service. For example, you can edit the factories to add location information.

Oracle IoT Production Monitoring Cloud Service automatically updates the work order status and produced quantities in Oracle Fusion Cloud Manufacturing based on updates from the machine or operator. The outbound sync frequency determines how often production output updates are synchronized with Oracle Fusion Cloud Manufacturing.

Support for Process Manufacturing Work Orders

Production Monitoring supports process manufacturing work orders in addition to discrete manufacturing work orders. Use the factory production view to see the various stages and operations for a process work order. The work order view, together with associated factory and machine metrics, is available for the primary product.

The product routing view is available if the product routing and production lines have been created. The following example shows the **Production** tab for a factory that uses process manufacturing work orders. You can select the product and work order to view the product routing information.



For each operation in the process work order, you can see the various serial and parallel routing tasks, together with the operator and machine resources associated with each routing task.

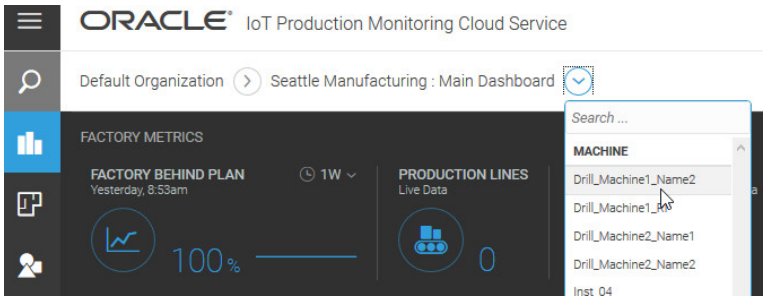
You can use both system and custom metrics with process work orders. System metrics, such as the number of in-process and pending work orders are available by default. You may also wish to create custom metrics that use work order data, such as batch quantity or reject/scrap data.

View the Manufacturing Resource for an Imported Machine

Machines imported in Oracle IoT Production Monitoring Cloud Service can link back to the corresponding manufacturing resource in Oracle Fusion Cloud Manufacturing.

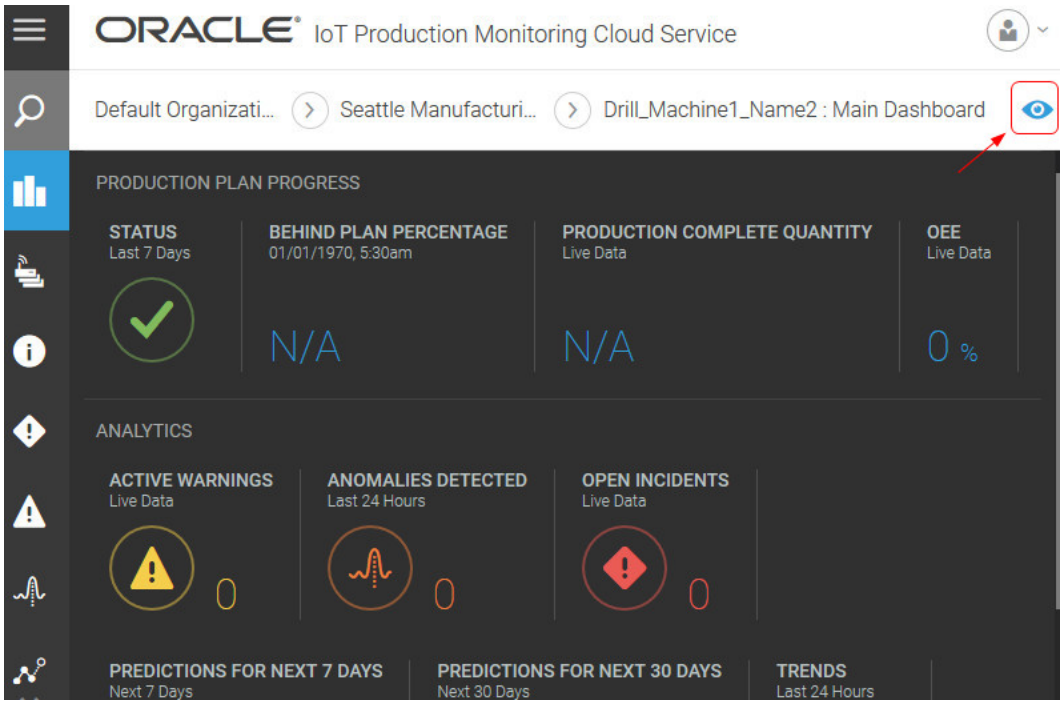
The main machine dashboard for each imported machine includes a link to the corresponding manufacturing resource in Oracle Fusion Cloud Manufacturing.

1. In the Operations Center factory view, use the breadcrumbs to navigate to a specific machine in the factory. You can also click the machine in the factory **Floor Plan** view or the **Production** view.

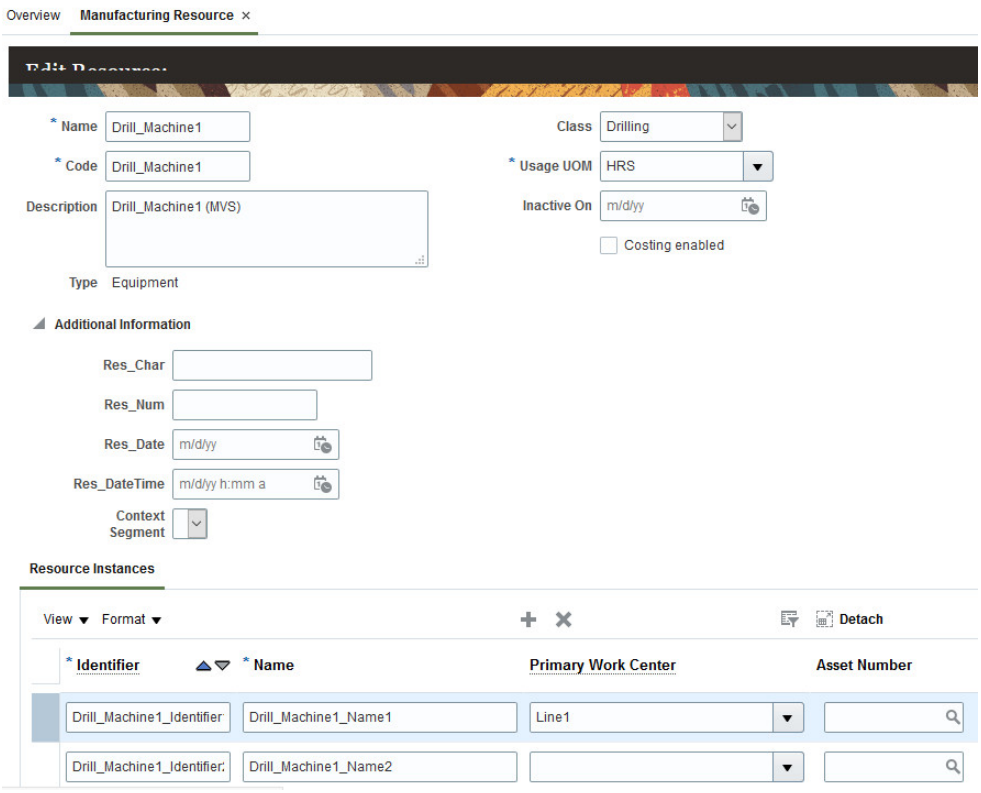


The main dashboard for the machine appears by default. The dashboard shows the real-time and historic performance data for the machine.

2. Click **View** to open the link to the manufacturing resource in Oracle Fusion Cloud Manufacturing.



A new browser tab directly opens the manufacturing resource page in Oracle Fusion Cloud Manufacturing. You may need to log in to Oracle Fusion Cloud Manufacturing if you are not already logged in. Note that the logged in user must have the *Manufacturing Engineer* role in Oracle Fusion Cloud Manufacturing to access the page.



Access the Work Orders

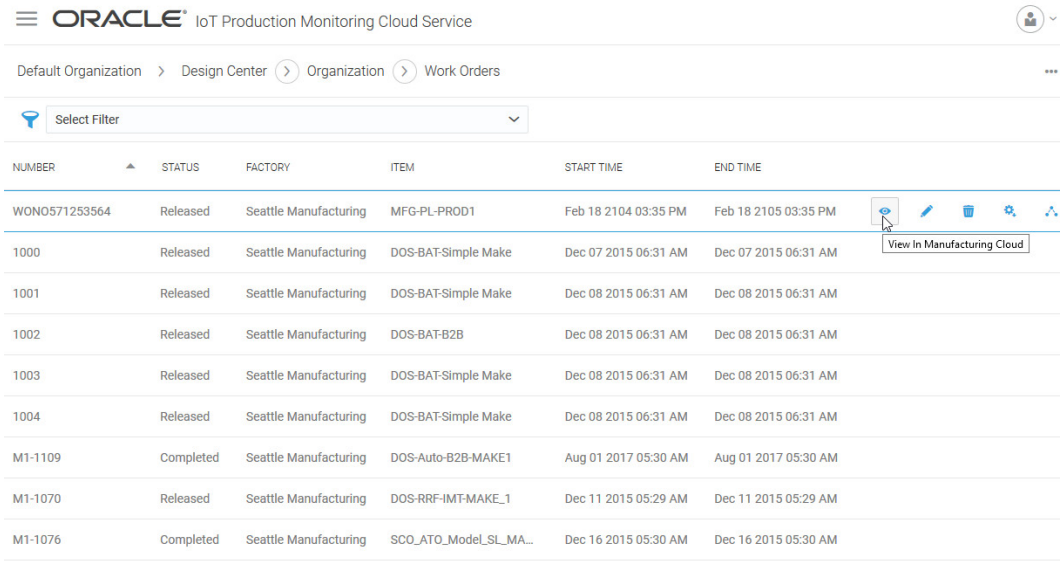
The work orders from Oracle Fusion Cloud Manufacturing automatically appear in Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

After enabling Oracle Fusion Cloud Manufacturing integration, you may have to wait for the work orders to appear until the first inbound sync between Oracle IoT Production Monitoring Cloud Service and Oracle Fusion Cloud Manufacturing is complete.

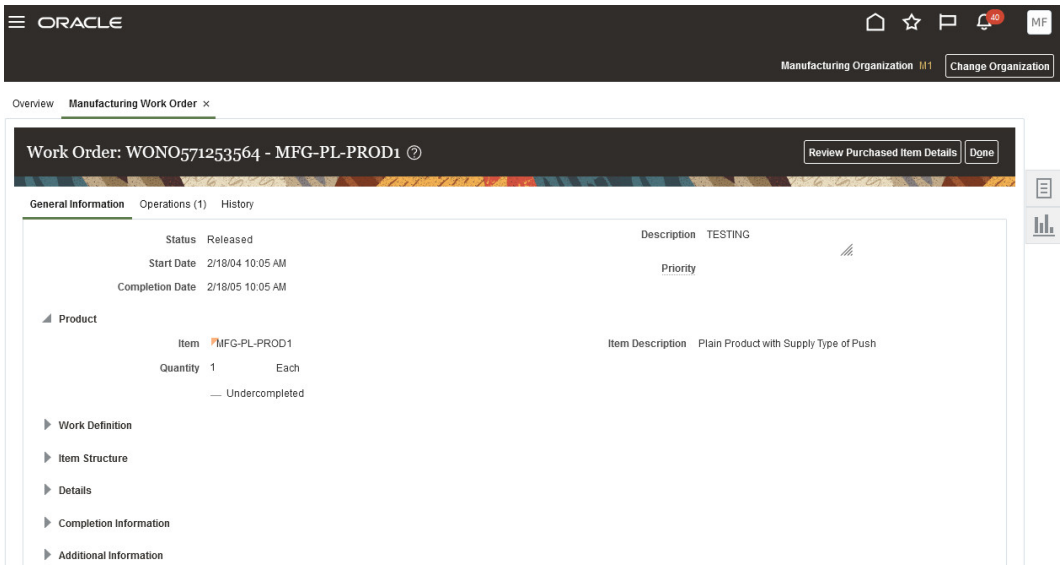
1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Work Orders** .

   The list of work orders downloaded from Oracle Fusion Cloud Manufacturing appears, and you can search and filter the list.

   You can download work orders as `csv` files, as individual work orders, or as a group of work orders. You can also upload edited work order files back to Oracle IoT Production Monitoring Cloud Service.
4. If you wish to open a work order directly in Oracle Fusion Cloud Manufacturing, click **View** against the work order row.



A new browser tab directly opens the work order page in Oracle Fusion Cloud Manufacturing. You may need to log in to Oracle Fusion Cloud Manufacturing if you are not already logged in.



Add Machines and Operators to Work Orders

You can edit the work orders to assign machines and operators to the work orders in Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

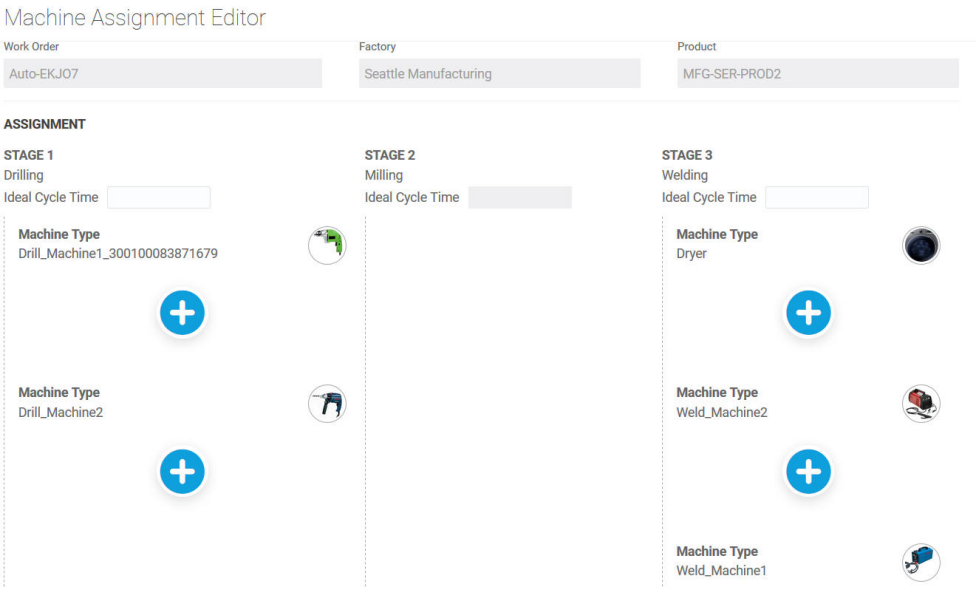
The work order data downloaded from Oracle Fusion Cloud Manufacturing includes machine type, and operator type, information (*Resource Id* and *Resource Name*). You need to ensure that your machines are of the required machine types created in Oracle IoT Production Monitoring Cloud Service. You can then edit the work orders to assign the machines in Oracle IoT Production Monitoring Cloud Service.

If your work order data contains operator type information, then you can also assign operators in Oracle IoT Production Monitoring Cloud Service

1. Click **Menu** and then click **Design Center**.
2. Select **Organization** from the **Design Center** menu.
3. Click **Work Orders** .
4. (Optional) Click Search and specify a criteria to filter the list of work orders.

   For example, you can filter the list for a particular factory or product.
5. To edit a work order's machine, and operator, assignments, click Edit next to a work order.

   The Resource Assignment Editor displays the **Work Order**, **Factory**, and **Product** names as read-only fields. In the ASSIGNMENT area, you can assign machines and operators for the stages (routing tasks), included in the work order.



6. Click the Add icons for the machines that you want to add to your work order.
7. If your work order includes operator types, click the Add icons for the operators that you want to add to your work order.
8. Click **Save.**

Assign Machines and Operators to Similar Work Orders

You can use a completed work order's data to assign the same machines and operators to other, similar work orders if these work orders belong to the same factory and product, and use the same routing tasks.

Use the following steps to assign machines and operators using an already assigned work order:

1. On the Work Orders page, click **Assign Resources to Other Work Orders** against a work order row that already has the machines and operators assigned for it.

   The Assign Resources to Work Orders dialog appears.

2. Select one or more work orders from the list that appears.

   The list of work orders includes work orders that are associated with the same factory and product.

3. Click **OK** to assign machines and operators to the selected work orders.

   Note that if you select work orders that do not have the same routing tasks as the original work order, then you will get error messages for the same.

Assign Machines from Another Work Order

You can assign machines to a work order by copying data from another, similar work order if the two work orders belong to the same factory and product, and use the same routing tasks.

Use the following steps to assign machines to a work order using another work order:

1. On the Work Orders page, click **Assign Machines from Another Work Order** against the work order for which you wish to assign machines.

   The Assign Machines from Work Order dialog appears.

2. Select the work order whose machine assignments you wish to copy.
3. Click **OK** to copy the machines from the selected work order.

Download, Edit, and Upload Work Orders

You can manually download work order data to your local disk, edit the work order resource assignments, and upload work orders back to Oracle IoT Production Monitoring Cloud Service.

Download Work Orders

To download all work orders:

1. To download all work orders listed on the Work Orders page, click **Menu** and select **Download All**.
2. Save the `csv` (comma-separated value) file to the desired location on your hard disk or storage device.

To download a specific work order:

1. On the Work Orders page, click **Download** against the work order row.
2. Save the `csv` (comma-separated value) file to the desired location on your hard disk or storage device.

Edit Work Orders

You can edit the work order `csv` file downloaded from Oracle IoT Production Monitoring Cloud Service to update the machine and operator assignments:

1. Open the `csv` file that you downloaded from Oracle IoT Production Monitoring Cloud Service
2. Edit the rows to update the machine and operator assignments. For example, you can choose to add resource IDs to each row.

   So, if a data row looks like the following:

   ```
   # Start Time, End Time, Work Order ID, Work Order Number, Work
   Order Status, Routing Task ID, Resource ID, Assigned Units, Ideal
   Cycle Time
   2017-10-01T13:05:20Z, 2017-12-11T03:32:00Z, 300100084274083,
   MFG1-1029, ORA_UNRELEASED, FD631293-3F86-4179-8256-D18EEDBDF797,
   300100073217818, 1, 18000000
   ```

   It may look like the following after adding a machine ID:

   ```
   # Start Time, End Time, Work Order ID, Work Order Number, Work
   Order Status, Routing Task ID, Resource ID, Assigned Units, Ideal
   Cycle Time, Machine ID
   2017-10-01T13:05:20Z, 2017-12-11T03:32:00Z, 300100084274083,
   MFG1-1029, ORA_UNRELEASED, FD631293-3F86-4179-8256-D18EEDBDF797,
   300100073217818, 1, 18000000, Machine550_1
   ```

Upload Work Orders

To upload a `csv` work order file back to Oracle IoT Production Monitoring Cloud Service:

On the Work Orders page, click **Menu** , select **Upload CSV File**, and then select the file to upload.

Delete Work Orders

You may wish to delete work orders, for example, to clean up a previously configured Oracle Fusion Cloud Manufacturing integration.

To delete all work orders:

1. To delete all work orders listed on the Work Orders page, click **Menu** and select **Delete All**.
2. Click **Delete** to confirm.

To delete a specific work order:

1. On the Work Orders page, click **Delete** against the work order row.
2. Click **Delete** to confirm.

Create Production Lines

As Oracle Fusion Cloud Manufacturing doesn't use production lines, you can choose to add the machines to a production line in Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

Use a separate production line for each factory.

1. Create a `csv` file for your production line data, which should look like the following:

   ```
   # Production Line ID,Production Line Name,Factory ID,Machine ID,Machine
   ID 2,...
   ABC123,productionLineNameFoo,factory123,machine123, machine550, ...
   ```

   Tip:

   To learn about the format that's used in Oracle IoT Production Monitoring Cloud Service, you can download a sample `csv` file from the **Production Line** section of the **Menu > Design Center > Organization > Uploads** page.

2. In Oracle IoT Production Monitoring Cloud Service, click **Menu** and then click **Design Center.**
3. Select **Organization** from the **Design Center** menu.
4. Click **Uploads** .
5. Under **Production Line**, click **Upload New**, and select the `csv` file that contains your production line information.

   A confirmation message appears after a successful upload.
6. To verify that the machines added to the work orders and production line appear in the production plan, click **View Data on Server** under **Production Plan** and view the production plan for all factories.

   The assigned machines are listed against their respective factories and stages (routing tasks).

View the Work Orders in Factory View

After you add work orders in Oracle Internet of Things (IoT) Production Monitoring Cloud Service and create the production line, you can view work orders in the Factory view.

Because the factory information in Oracle Fusion Cloud Manufacturing doesn't include the factory address and floor plans, you need to add this information in Oracle IoT Production Monitoring Cloud Service.

1. Locate your factory in the Map view and click the Factory icon to view the factory details.
2. In the Factory view, select the **Production** tab.
3. From the **Products** list, select the relevant product.
4. From the **Work Orders** list, select the work order name.

   The In Plan section shows the machines that are part of the work order and production plan. Each stage in the work order can contain one or more parallel routing tasks. Each routing task can in turn have one or more machines associated with it. If a routing task has other qualifying machines, you can click the **Qualified Machines** icon to view the details of these machines. A list of qualifying machines that have the same machine type, but aren't part of the work order is displayed.

> **Note:**
>
> The resource assignments for future production plans are shown as well. So, if your work order has a stage that has a start date in the future, the machine and operator assignments for the future stage are also included.

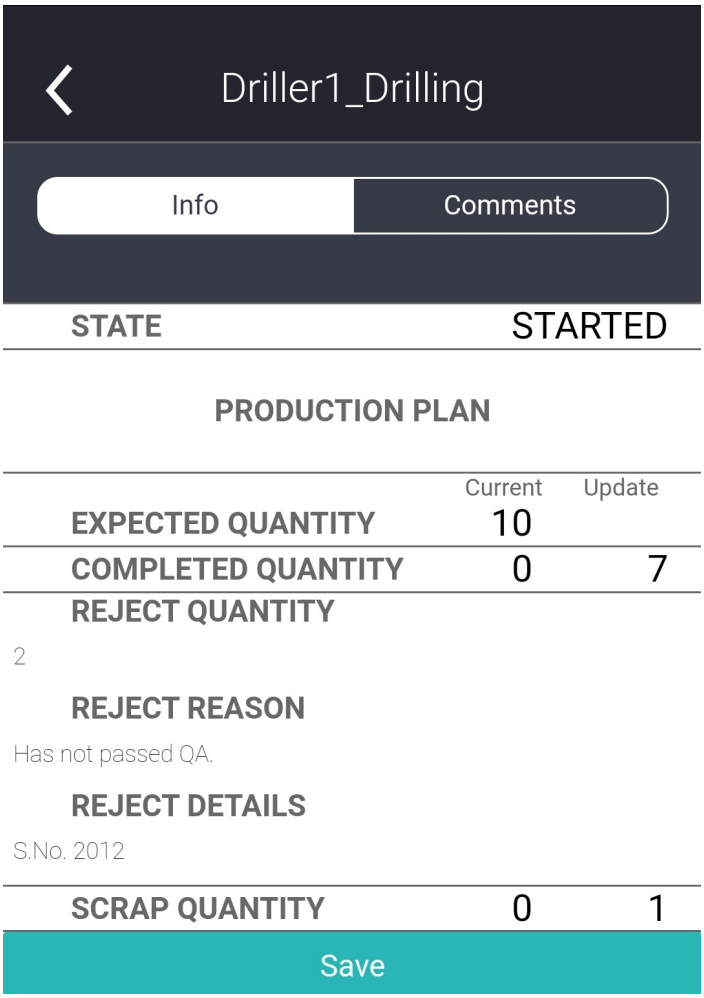
Verify Work Order Status and Produced Quantities

Oracle IoT Production Monitoring Cloud Service automatically updates the work order status and produced quantities in Oracle Fusion Cloud Manufacturing based on updates from the machine or operator.

When the production for a work order is started, and a machine or operator updates the output quantities, including bad quantities, the data is synced with Oracle Fusion Cloud Manufacturing.

> **Note:**
>
> If you were to directly update the quantities or operation status in Oracle Fusion Cloud Manufacturing, then these are not synced back with Oracle IoT Production Monitoring Cloud Service.

In the following example, a user with Operator privilege uses the mobile app to start a production routing task and set the output quantities including reject and scrap quantities.



The work order status and production output quantities are sync'd to Oracle Fusion Cloud Manufacturing at periodic intervals.

If bad quantities (reject and scrap quantities) are produced during an intermediate resource instance completion step, they are synced with Oracle Fusion Cloud Manufacturing without waiting for the last resource instance completion step. Completed quantities are sent only from the last stage of each operation.

If you are using the **Reject Reason** and **Scrap Reason** fields, these must match one of the user-defined reason codes in Oracle Fusion Cloud Manufacturing. You can check or add the reason codes using the **Manage Production Lookups** task under the **Setup and Maintenance** area in Oracle Fusion Cloud Manufacturing.

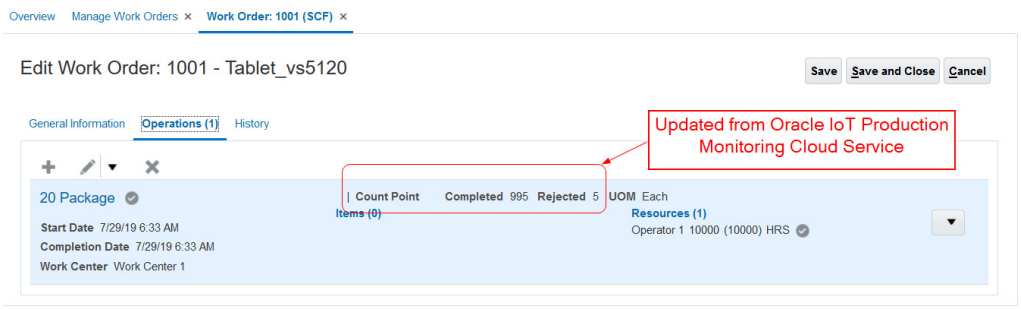
The **Reject Details** and **Scrap Details** fields can contain free-form text.

When updating the output quantities in Oracle Fusion Cloud Manufacturing, Oracle IoT Production Monitoring Cloud Service also passes the name of the user/operator who produced the quantities in a work order. This helps in calculating efficiencies by identifying the quantities produced by each operator.

> **Note:**
>
> In Oracle Fusion Cloud Manufacturing, the descriptive flexfield (DFF) *Work Order Operation Transactions* (`OperTxn_Char`) has a 10 character length, by default. If your operator names are longer, you can set this length to the desired value in Oracle Fusion Cloud Manufacturing. Any operator names longer than the `OperTxn_Char` character length in Oracle Fusion Cloud Manufacturing are automatically truncated to the `OperTxn_Char` character length.
> If the `OperTxn_Char` DFF is not configured in Oracle Fusion Cloud Manufacturing, then Oracle IoT Production Monitoring Cloud Service does not send the operator name with the operation transaction details.

In Oracle Fusion Cloud Manufacturing, navigate to **Supply Chain Execution > Work Execution** and select **Manage Work Orders** from the **Tasks** menu to search your work order.

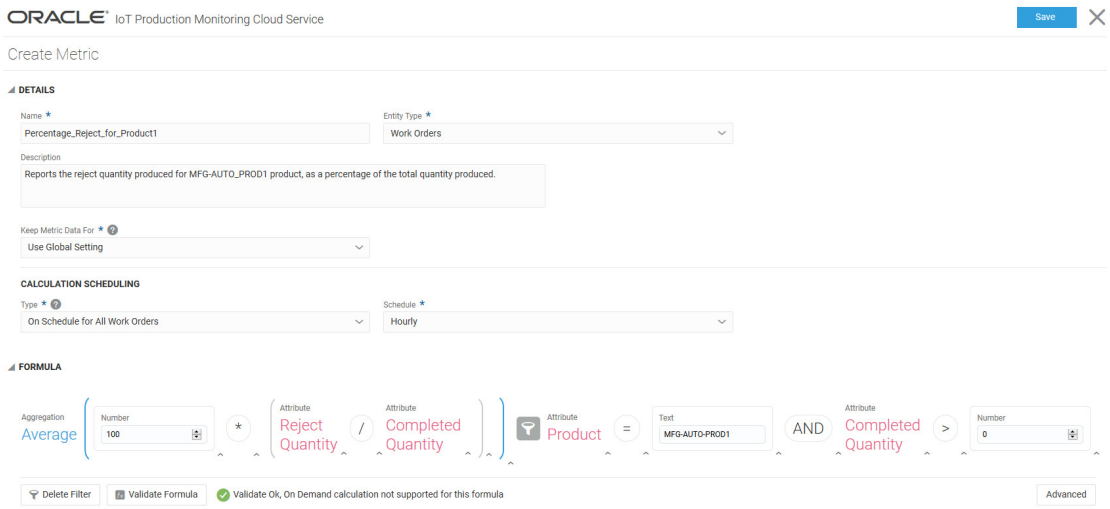
The following image shows the **Operations** tab for a work order in Oracle Fusion Cloud Manufacturing, which shows the last known count of completed quantities and bad quantities.



Use Work Order Data in Metrics and Rules

You can create custom metrics for your organization using data from your work order attributes, such as `actualStartTime`, `actualEndTime`, `Completed Quantity`, `Reject Quantity` and `Scrap Quantity`.

For example, you can create a metric to report the reject quantity produced for a product, as a percentage of the total quantity produced.



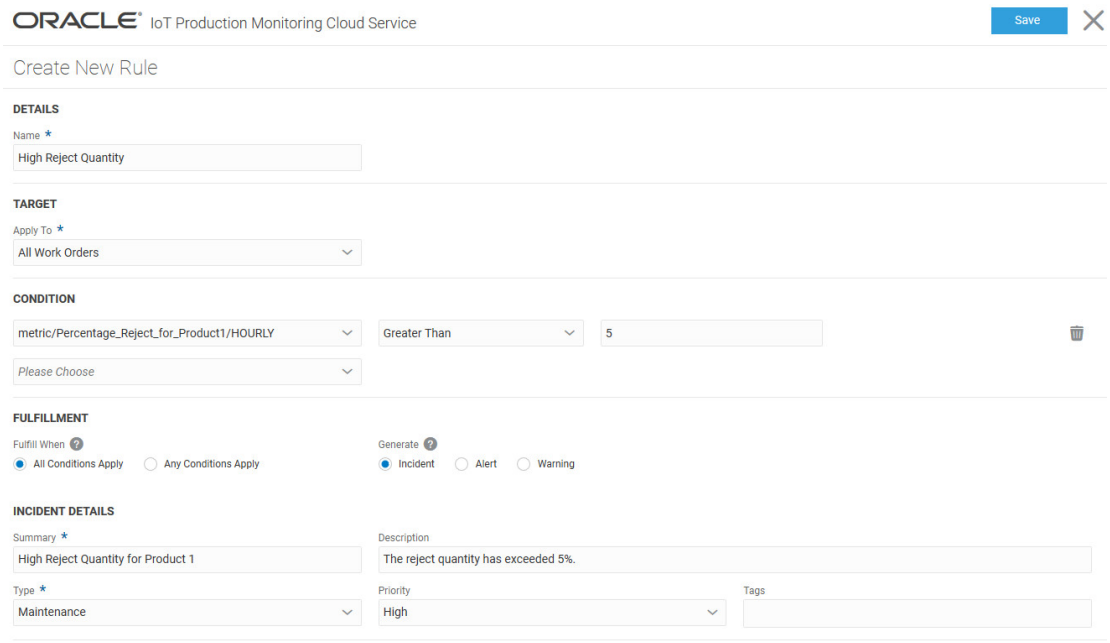
The following example calculates the average delay between the actual end time and the planned end time. The `Where` condition checks to ensure that the work order has completed. The resultant time difference is returned in milliseconds.

```
SELECT AVG('actualEndTime'-'plannedEndTime') FROM 'workOrders' WHERE
'actualEndTime'>0
```

See Define Your Own Metrics for more information on creating custom metrics.

Like other custom metrics, you can add work-order based metrics to your main dashboard, or custom dashboards.

Create rules based on your work-order based metrics to trigger alerts. For example, you can create a rule to generate an incident if the reject percentage exceeds 5%.



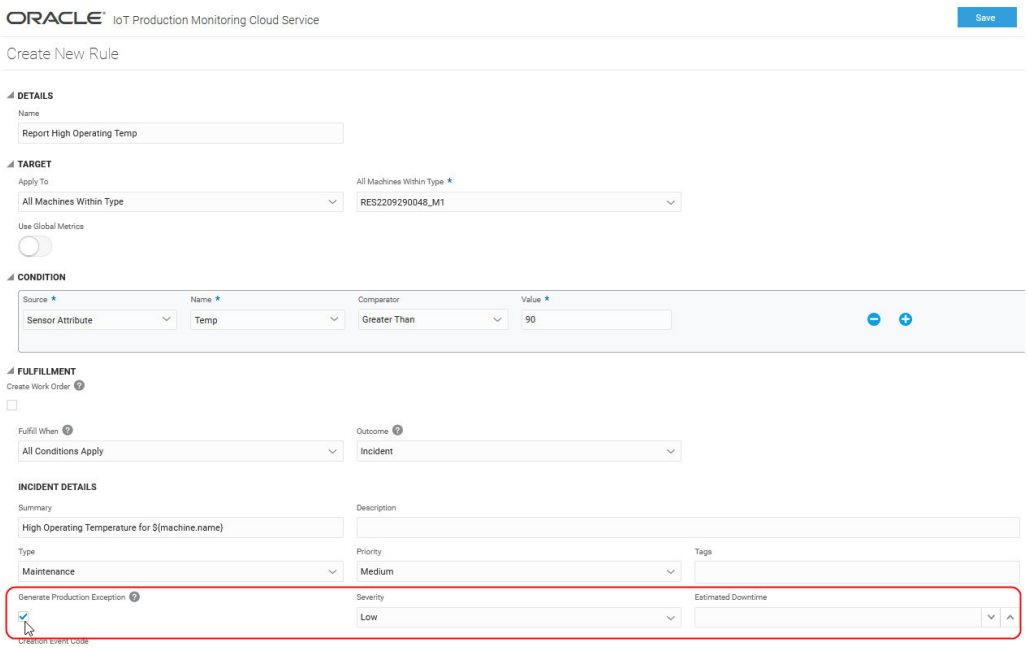
See Define Rules to Trigger Incidents for more information on creating rules.

Video

Production Exceptions for Machine Incidents

Production Monitoring can notify Manufacturing Cloud about machine incidents that affect the completion of a work order. The notifications can include additional details, such as the incident severity and estimated downtime.

You can configure rules to create production exceptions in Manufacturing Cloud corresponding to incidents in Production Monitoring. The following image shows an example of a rule editor that is used to create a production exception in Manufacturing.



When you subsequently resolve or withdraw an incident in Production Monitoring, IoT automatically closes the production exception in Manufacturing Cloud. Alternatively, if you close the production exception in Manufacturing Cloud, the incident is automatically resolved in Production Monitoring. If you also happen to have a maintenance work order for the same incident in Maintenance Cloud, then the incident status is updated to *Work in Progress* in Production Monitoring.

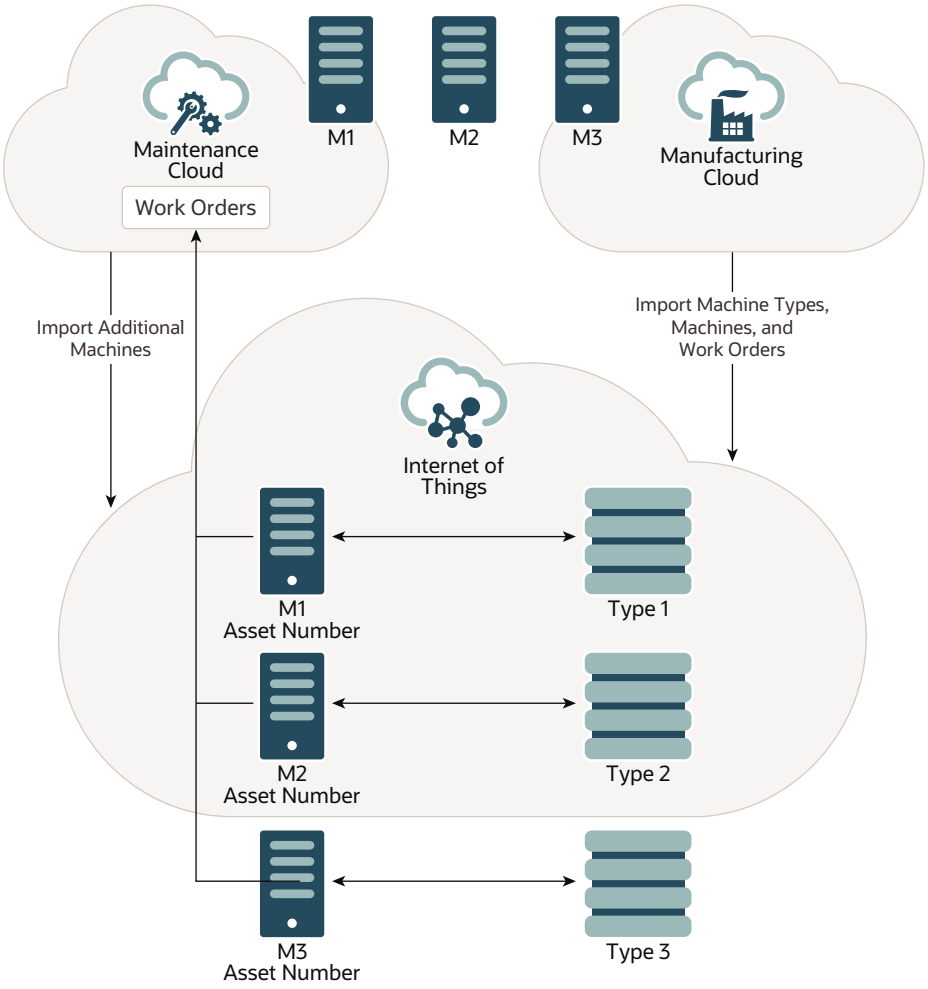
Using Oracle Fusion Cloud Manufacturing Together with Oracle Fusion Cloud Maintenance

You can map your Oracle Fusion Cloud Manufacturing machines as maintainable assets in Oracle Fusion Cloud Maintenance.

In Oracle Fusion Cloud Manufacturing, map the resource instances to asset numbers of the corresponding assets in Oracle Fusion Cloud Maintenance.

When an incident is created against an imported machine in Oracle IoT Production Monitoring Cloud Service, the incident automatically translates into a work order for the corresponding asset in Oracle Fusion Cloud Maintenance.

When using both Oracle Fusion Cloud Manufacturing and Oracle Fusion Cloud Maintenance, import machines from Oracle Fusion Cloud Manufacturing. Use the Oracle Fusion Cloud Maintenance integration to create automatic maintenance work orders for machines imported from Oracle Fusion Cloud Manufacturing.



Configure and Use the Three-Way Integration

Set the asset numbers for your resource instances (machines) in Oracle Fusion Cloud Manufacturing, so as to map them to their corresponding asset numbers in Oracle Fusion Cloud Maintenance.

1. Create assets in Oracle Fusion Cloud Maintenance that correspond to the resource instances (machines) in Oracle Fusion Cloud Manufacturing.

   Ensure that you enable the **Allow Work Orders** option for every asset. Setting this option lets Oracle IoT Production Monitoring Cloud Service create outbound work orders in Oracle Fusion Cloud Maintenance.
   You do not need to set the **Enable IoT** option, as the machines in Oracle IoT Production Monitoring Cloud Service are imported from Oracle Fusion Cloud Manufacturing.

2. Create the corresponding resource instances in Oracle Fusion Cloud Manufacturing.

Set the **Asset Number** for each resource instance that you create. This attribute must be the same as the asset number of the corresponding asset in Oracle Fusion Cloud Maintenance.

3. Enable Oracle Fusion Cloud Manufacturing integration in Oracle IoT Production Monitoring Cloud Service.

   See the following topics for more information:

   - Add the IoT Application Integration Entry in Oracle Fusion Cloud Manufacturing
   - Add an Oracle Fusion Cloud Manufacturing Integration
   - Enable and Configure the Oracle Fusion Cloud Manufacturing Integration
   - Enable a Manufacturing Organization for IoT Synchronization

   After you have enabled Oracle Fusion Cloud Manufacturing integration, machines are automatically imported into Oracle IoT Production Monitoring Cloud Service for the enabled manufacturing organizations.

4. Enable Oracle Fusion Cloud Maintenance integration in Oracle IoT Production Monitoring Cloud Service.

   See Add an Oracle Fusion Cloud Maintenance Integration for more information.

5. Create rules in Oracle IoT Production Monitoring Cloud Service to define incident conditions and the corresponding work orders that get created in Oracle Fusion Cloud Maintenance.

   See Configure Rules to Generate Automatic Maintenance Work Orders for more information.

> **Note:**
>
> If you have additional assets in Oracle Fusion Cloud Maintenance that do not have corresponding machines in Oracle Fusion Cloud Manufacturing, you can manually import these assets into Oracle IoT Production Monitoring Cloud Service. See Import Machines from Oracle Fusion Cloud Maintenance for more information on directly importing Oracle Fusion Cloud Maintenance assets.

Using Predictions and Anomalies in Supply Planning

Oracle Supply Chain Planning can make use of the predictions and anomalies generated for your manufacturing resource instances to help with Supply Planning.

The Planning Advisor interface in Supply Planning lets you plan your shop floor resources using downtime event prediction inputs from Production Monitoring. Production Monitoring provides real-time production planning capabilities by helping you understand the impact to your order due date commitments, and enabling you to re-adjust the plan. You can respond to failures before they happen and take mitigating actions, such as offloading to alternate resources.

For detailed information on this feature, including prerequisites, configuration steps, and usage, please refer to the *Using Supply Planning* guide:

- *Using Supply Planning*: Downtime Alerts for Resources in Supply Plan

- Demo Video

Frequently Asked Questions on Integration Issues

Commonly seen issues with Oracle Fusion Cloud Manufacturing integration relate to work order updates, inbound sync, and outbound sync related items.

My changes to work order resource assignments in Oracle Fusion Cloud Manufacturing are not being imported into Oracle IoT Production Monitoring Cloud Service.

In certain scenarios, such as resource assignment changes in Oracle Fusion Cloud Manufacturing for work orders already imported into Oracle IoT Production Monitoring Cloud Service, you may not see the updates reflect back in Oracle IoT Production Monitoring Cloud Service. Use the following workaround for such scenarios:

When you make work order updates in Oracle Fusion Cloud Manufacturing, update one of the work order header parameters, such as the work order **Description** field.

My changes to resource assignments for imported work orders in Oracle IoT Production Monitoring Cloud Service are not synced back to Oracle Fusion Cloud Manufacturing

You can change the resource assignments for your imported work orders in Oracle IoT Production Monitoring Cloud Service. However, these changes are not exported back to Oracle Fusion Cloud Manufacturing.

I made some resource assignments for imported work orders in Oracle IoT Production Monitoring Cloud Service, but then subsequently modified the resource assignments in Oracle Fusion Cloud Manufacturing. Can these changes be reconciled?

The next inbound sync from Oracle Fusion Cloud Manufacturing to Oracle IoT Production Monitoring Cloud Service overrides the assignments you made in Oracle IoT Production Monitoring Cloud Service. Oracle Fusion Cloud Manufacturing is the source of truth for these resource assignments.

If I update production output details directly in Oracle Fusion Cloud Manufacturing, are these imported back to Oracle IoT Production Monitoring Cloud Service?

Actual production details are updated from Oracle IoT Production Monitoring Cloud Service to Oracle Fusion Cloud Manufacturing. We currently do not support importing actual production details from Oracle Fusion Cloud Manufacturing into Oracle IoT Production Monitoring Cloud Service.

If I update a work order operation status directly in Oracle Fusion Cloud Manufacturing, is the operation status updated in Oracle IoT Production Monitoring Cloud Service?

No. Work order operation statuses are not imported from Oracle Fusion Cloud Manufacturing into Oracle IoT Production Monitoring Cloud Service.

When an operator updates the work order operation in Oracle IoT Production Monitoring Cloud Service using the mobile application, the changes are synced with Oracle Fusion Cloud Manufacturing. Alternately, a machine can also update the work order operation with a device message, and the changes are synced with Oracle Fusion Cloud Manufacturing. Oracle IoT Production Monitoring Cloud Service automatically changes the status of the work order operation to *Started* when the first production output is sent for an operation stage.

I am running into problems when updating output quantities in Oracle IoT Production Monitoring Cloud Service along with reject and scrap quantities.

If you are using the **Reject Reason** and **Scrap Reason** fields, these must match one of the user-defined reason codes in Oracle Fusion Cloud Manufacturing. You can check or add the reason codes using the **Manage Production Lookups** task under the **Setup and Maintenance** area in Oracle Fusion Cloud Manufacturing.

The **Reject Details** and **Scrap Details** fields can contain free-form text.

See Verify Work Order Status and Produced Quantities for more information about updating output quantities.

How do parallel resources work in a work order?

If a work order routing stage has two or more parallel resources, then Oracle IoT Production Monitoring Cloud Service exports actual production details only from the resource instance marked as principal.

Currently, Oracle Fusion Cloud Manufacturing does not have a flag to indicate whether the resources are working independently or in parallel. To avoid duplication of actual quantities, Oracle IoT Production Monitoring Cloud Service assumes that the parallel resources work together and produce the same set of products.

The work order status in Oracle IoT Production Monitoring Cloud Service is not updated automatically after production begins.

After production begins, Oracle IoT Production Monitoring Cloud Service automatically changes the work order operation status to *Started*. Oracle IoT Production Monitoring Cloud Service does not, however, update the work order status, say from *Unreleased* to *Released*.

If I update work order status to complete, does Oracle IoT Production Monitoring Cloud Service automatically update the actual quantities to match the expected quantity?

No. Actual quantities are updated by a machine or operator.

The output quantities are updated in Oracle Fusion Cloud Manufacturing, but the operator name is missing.

If the `OperTxn_Char` DFF is not configured in Oracle Fusion Cloud Manufacturing, then Oracle IoT Production Monitoring Cloud Service does not send the operator name with the operation transaction details.

In Oracle Fusion Cloud Manufacturing, the descriptive flexfield (DFF) *Work Order Operation Transactions* (`OperTxn_Char`) has a 10 character length, by default. If your operator names are longer, you can set this length to the desired value in Oracle Fusion Cloud Manufacturing. Any operator names longer than the `OperTxn_Char` character length in Oracle Fusion Cloud Manufacturing are automatically truncated to the `OperTxn_Char` character length.

See Verify Work Order Status and Produced Quantities for more information on updating output quantities.

Integrate Oracle Fusion Cloud Maintenance with Oracle IoT Production Monitoring Cloud Service

Use Oracle Fusion Cloud Maintenance integration to automatically create maintenance work orders for your machines in Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

You can choose to import machines from Oracle Fusion Cloud Maintenance into Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

You must have the machine types already defined in Oracle IoT Production Monitoring Cloud Service for the machines that you wish to import from Oracle Fusion Cloud Maintenance. If you are also integrating with Oracle Fusion Cloud Manufacturing, then the machine types can also come from Oracle Fusion Cloud Manufacturing.

After you import machines and associate the machines with sensors, you can configure rules to conditionally generate incidents and automatic work orders in Oracle Fusion Cloud Maintenance.

For example, you can have a threshold rule that triggers an incident when a device associated with a machine overheats. An outbound work order corresponding to the incident is automatically generated in Oracle Fusion Cloud Maintenance.

When you release, close, cancel, or modify the work order in Oracle Fusion Cloud Maintenance, the status of the corresponding incident is automatically updated inOracle IoT Production Monitoring Cloud Service. The synchronization between Oracle IoT Production Monitoring Cloud Service and Oracle Fusion Cloud Maintenance happens every 5 minutes.

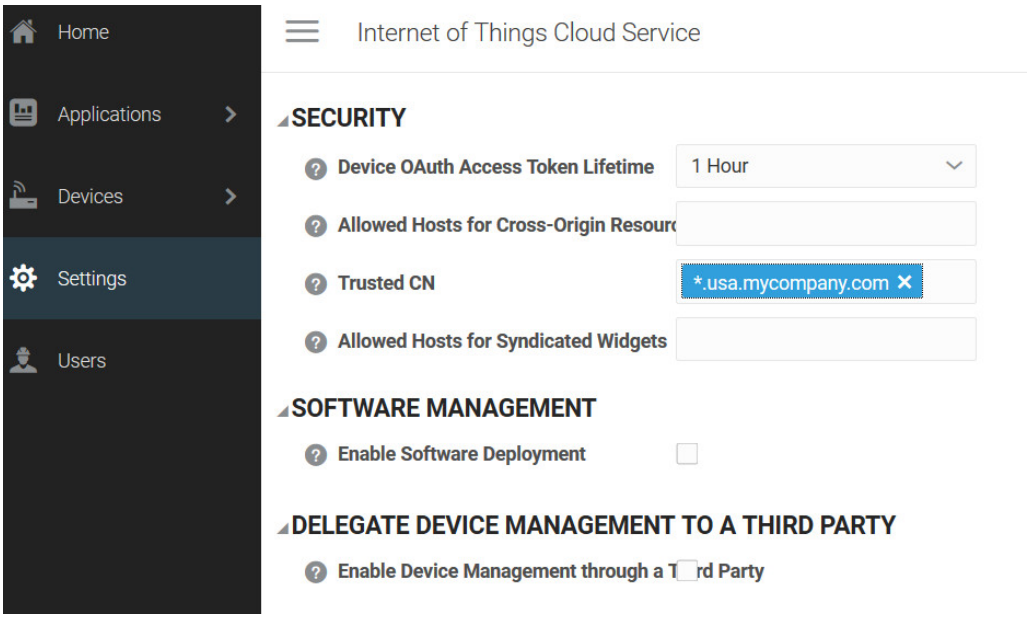
> **Note:**
>
> If you manually modify the status of an incident in Oracle IoT Production Monitoring Cloud Service, the change is not synchronized with the work order in Oracle Fusion Cloud Maintenance.

Add an Oracle Fusion Cloud Maintenance Integration

Use the Integrations page in Oracle Internet of Things (IoT) Production Monitoring Cloud Service to add an integration with Oracle Fusion Cloud Maintenance.

Before you configure Oracle Fusion Cloud Maintenance integration, make sure your Oracle Fusion Cloud Maintenance host is trusted by your Oracle Internet of Things Intelligent Applications Cloud domain.

Host names with `.oraclecloud.com` and `.oraclecloudapps.com` suffixes are always allowed. If your Oracle Fusion Cloud Maintenance domain name is different, then add the domain as a trusted CN in the Oracle Internet of Things Intelligent Applications Cloud management console. To do this, add `*.`*`YourDomain`*`.com` under **Trusted CN** in the Settings page.



You can access your Oracle Internet of Things Intelligent Applications Cloud management console at the following URL:

`https://hostname/ui`

Here, *hostname* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

To add an integration with Oracle Fusion Cloud Maintenance:

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.

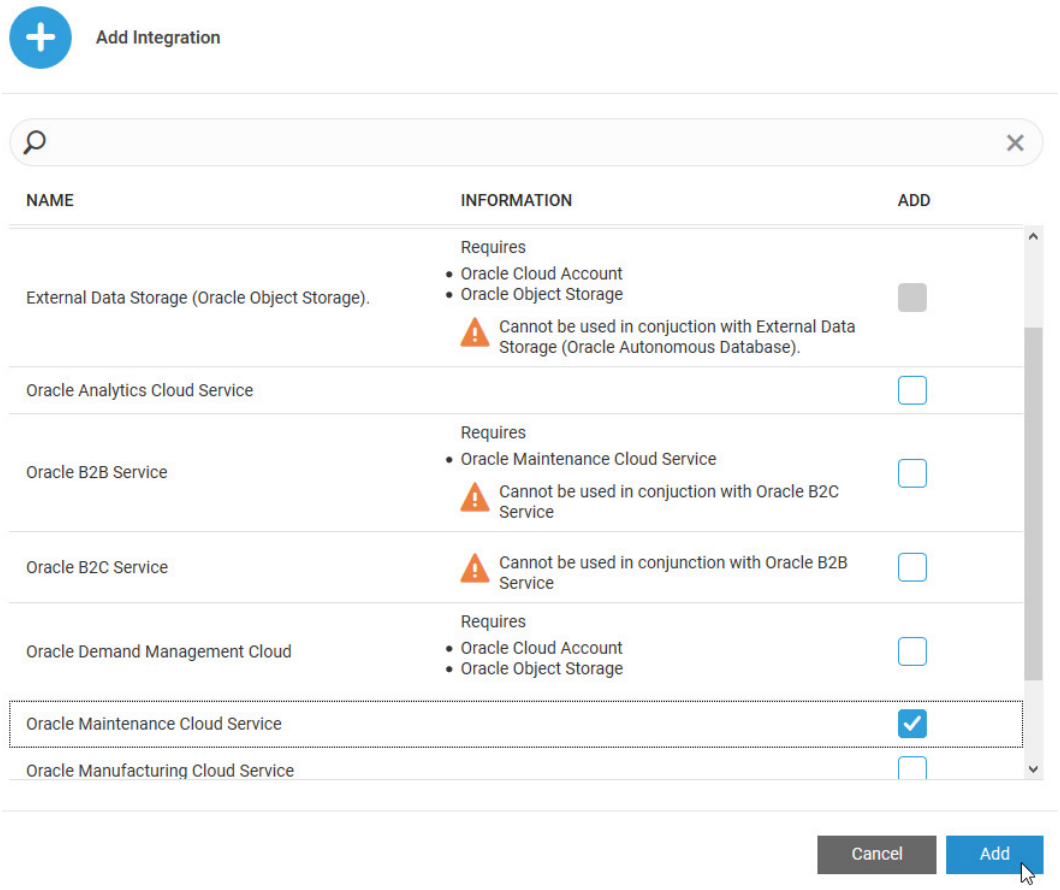
   You can access Oracle IoT Production Monitoring Cloud Service at the following URL:

   `https://hostname/pm`

   Here, *hostname* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

   If you are in the Design Center, you need to click **Previous** (❮) before you see the **Settings** option in the menu.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **Oracle Maintenance Cloud Service** and click **Add**.

   Tip: You can also search for an integration name in the list.



Oracle Maintenance Cloud Service integration gets added to the Integrations page.

5. On the Integrations page, under **Oracle Maintenance Cloud Service**, click **Connect**.
6. Specify the **Service URL** for your Oracle Fusion Cloud Maintenance instance.

   The Service URL is the URL of your Oracle Fusion Cloud Maintenance host. No port number is necessary here.

   For example: `https://MyMntCloud.oraclecloud.com`.
7. Specify the **User Name** for your Oracle Fusion Cloud Maintenance instance.
8. Specify the **Password** for your Oracle Fusion Cloud Maintenance instance.
9. Click **Verify Connectivity** to verify connectivity to the Oracle Fusion Cloud Maintenance instance.

   If the connection succeeds, then the **Save** button gets enabled.
10. Click **Save** to save the connection settings.

Enable and Configure the Oracle Fusion Cloud Maintenance Integration

To start using Oracle Fusion Cloud Maintenance integration, enable and configure the integration for **Oracle Maintenance Cloud Service** on the Integrations page.

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.

2. Click **Integrations**.
3. Under **Oracle Maintenance Cloud Service**, click **Edit Configuration**.
4. Toggle the **Integration Status** switch to **ON**.

   This enables your Oracle Fusion Cloud Maintenance integration.
5. Specify the **Synchronization** frequency in minutes.

   The sync frequency determines how often Oracle IoT Production Monitoring Cloud Service syncs with Oracle Fusion Cloud Maintenance.
6. Click **Save** to save your configuration settings.

You may next proceed to import machines from Oracle Fusion Cloud Maintenance.

Import Machines from Oracle Fusion Cloud Maintenance

You can choose to import Oracle Fusion Cloud Maintenance assets as machines into Oracle IoT Production Monitoring Cloud Service.

You must have the machine types already defined in Oracle IoT Production Monitoring Cloud Service for the machines that you wish to import from Oracle Fusion Cloud Maintenance. If you are also integrating with Oracle Fusion Cloud Manufacturing, then the machine types can also come from Oracle Fusion Cloud Manufacturing.

If you are also integrating with Oracle Fusion Cloud Manufacturing, then the resource instances in Oracle Fusion Cloud Manufacturing that have associated asset numbers for the corresponding assets in Oracle Fusion Cloud Maintenance are already present in Oracle Internet of Things (IoT) Production Monitoring Cloud Service. If you have additional assets in Oracle Fusion Cloud Maintenance that are not present in Oracle Fusion Cloud Manufacturing, you can import these into Oracle IoT Production Monitoring Cloud Service.

1. In Oracle Internet of Things (IoT) Production Monitoring Cloud Service, click **Menu** and then click **Design Center**.
2. Select **Machines** from the **Design Center** menu.
3. Click **Import**.
4. Under **Source**, ensure that **Maintenance Cloud (MNT)** is selected.
5. Select a pre-existing **Machine Type** for the machines that you are importing.

   You must have either defined a machine type in Oracle IoT Production Monitoring Cloud Service, or imported the machine type from Oracle Fusion Cloud Manufacturing.
6. Search for Oracle Fusion Cloud Maintenance machines to import:
   a. Select **Maintainable Machines** or **All Machines** to search for in Oracle Fusion Cloud Maintenance.
   b. In the **Search Parameters** list, select **Name, Type** (**Item** in Oracle Fusion Cloud Maintenance), or **Organization Code**.
   c. Specify the corresponding **Name, Type,** or **Organization Code** value.

> **Note:**
>
> The search value field is case sensitive.

d. Click **Search**.

7. Select the machines that you want to import from the search results.
8. Click **Import**.

The selected machines are imported into Oracle IoT Production Monitoring Cloud Service.

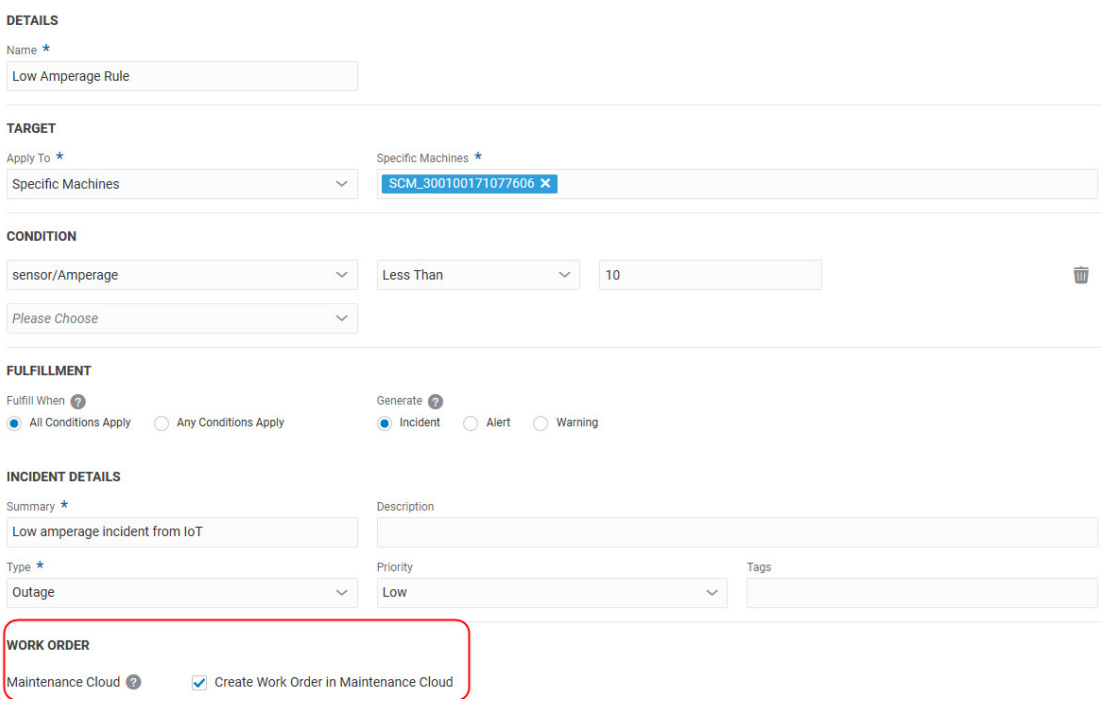
Configure Rules to Generate Automatic Maintenance Work Orders

Configure rules to automatically create work orders in Oracle Fusion Cloud Maintenance when an incident is created in Oracle IoT Production Monitoring Cloud Service.

When creating incident rules in Oracle IoT Production Monitoring Cloud Service, an additional Work Order section appears for machines synced with Oracle Fusion Cloud Maintenance.

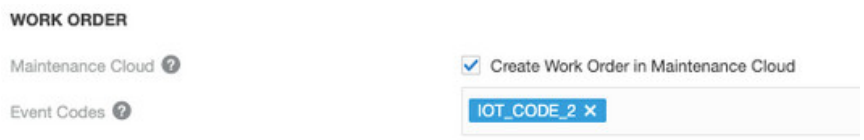
For basic information on using rules in Oracle IoT Production Monitoring Cloud Service, see Define Rules to Trigger Incidents.

If you are creating a rule to generate an incident for an imported asset, click **Create Work Order in Maintenance Cloud**.



Use Condition Event Codes

If you have defined condition event codes in Oracle Fusion Cloud Maintenance for your IoT assets, then you can pass the event code corresponding to the incident back to Oracle Fusion Cloud Maintenance. Select the **Event Codes** to pass to Oracle Fusion Cloud Maintenance when the incident rule is triggered.



You can define maintenance programs in Oracle Fusion Cloud Maintenance to act on the incident based on the event code passed back by Oracle IoT Production Monitoring Cloud Service. The maintenance program can trigger one or more work orders in Oracle Fusion Cloud Maintenance based on the reported incident.

> **Note:**
>
> The **Event Codes** field appears only when you are creating a rule for a machine mapped to a specific asset in Oracle Fusion Cloud Maintenance. If you are creating a generic rule for a machine type, then the event codes aren't available, as the machine type can have machines in Oracle IoT Production Monitoring Cloud Service that are not imported from Oracle Fusion Cloud Maintenance.

See Also: How You Manage Condition Event Codes in the *Oracle SCM Cloud Using Maintenance* guide.

Verify and Update the Work Orders in Oracle Maintenance Cloud

When an incident is created for an imported machine in Oracle Internet of Things (IoT) Production Monitoring Cloud Service, the corresponding work order is automatically created in Oracle Fusion Cloud Maintenance.

When a rule incident has an associated work order, you can open the work order directly in Oracle Fusion Cloud Maintenance from the Incidents page in Operations Center. The link is available under the **Maintenance Cloud Work Orders** section for the incident.

> **Note:**
>
> The scheduler job synchronizes the Oracle Fusion Cloud Maintenance with Oracle IoT Production Monitoring Cloud Service every 5 minutes.

You can also manually search for a work order in your Oracle Fusion Cloud Maintenance instance using the following steps:

1. Sign in to your Oracle Fusion Cloud Maintenance instance.
2. Navigate to **Maintenance Management**.
3. Under **Tasks**, select **Manage Maintenance Work Orders**.
4. Click **Search Filters** to specify criteria, such as the asset name and work order creation time, for your search.

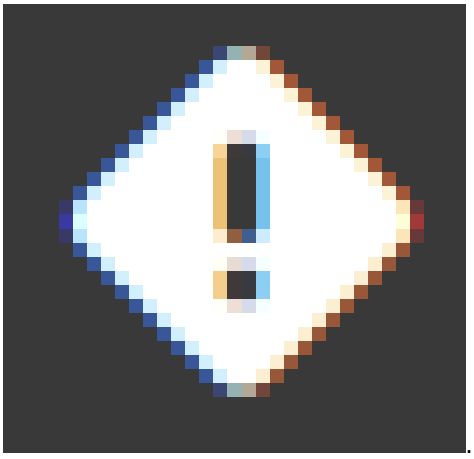
5. Select one or more work order rows from the search results.
   - Click **Release** to release the selected work orders.
   - Click **Mass Action** to change the status of the work orders.

   When you change the status of a work order in Oracle Fusion Cloud Maintenance, the status of the incident in Oracle IoT Production Monitoring Cloud Service is automatically updated. For example, when you release a work order in Oracle Fusion Cloud Maintenance, the status of the corresponding incident in Oracle IoT Production Monitoring Cloud Service changes from **New** to **Open.** When you close or cancel a work order, the status for the associated incident changes to **Withdrawn.**

Verify Incident Status Update in Oracle IoT Production Monitoring Cloud Service

When you change the status of a work order in the Oracle Fusion Cloud Maintenance, the associated incident status is automatically updated in Oracle Internet of Things (IoT) Production Monitoring Cloud Service.

> **Note:**
>
> The scheduler job synchronizes the Oracle Fusion Cloud Maintenance with Oracle IoT Production Monitoring Cloud Service every 5 minutes.

1. Click **Menu**, and then click **Operations Center**.
2. Click **Incidents**  .
3. Use one of the following methods to verify the status of an incident:
   - In the Incidents table, view the **Status** column value that corresponds to the incident.
   - Search for the incident by using incident filters.

Integrate with Oracle Analytics Cloud

Oracle IoT Production Monitoring Cloud Service lets you sync factory, machine, and metric data with Oracle Analytics Cloud. You can use analyses, projects, and dashboards in Analytics Cloud to find the answers that you need from key IoT factory data displayed in graphical formats.

> **Note:**
>
> Oracle Analytics Cloud integration is now deprecated and will be removed in a future release.

An analysis is a query against your organization's IoT factory data that provides you with answers to business questions. For example, you may want to know the factory-wise incident numbers. Analyses enable you to explore and interact with information visually in tables, graphs, pivot tables, and other data views. You can also save, organize, and share the results of analyses with others.

A project enables you to dynamically explore multiple data sets in graphical way, all within a single interface. So, for example, you can combine the factory, machine, and metric data sets in a project. You can upload data from many commonly used data sources to create robust sets of information within project visualizations.

Dashboards can include multiple analyses to give you a complete and consistent view of your company's information across all departments and operational data sources. Dashboards provide you with personalized views of information in the form of one or more pages, with each page identified with a tab at the top. Dashboard pages display anything that you have access to or that you can open with a web browser including analyses results, images, text, links to websites and documents, and embedded content such as web pages or documents.

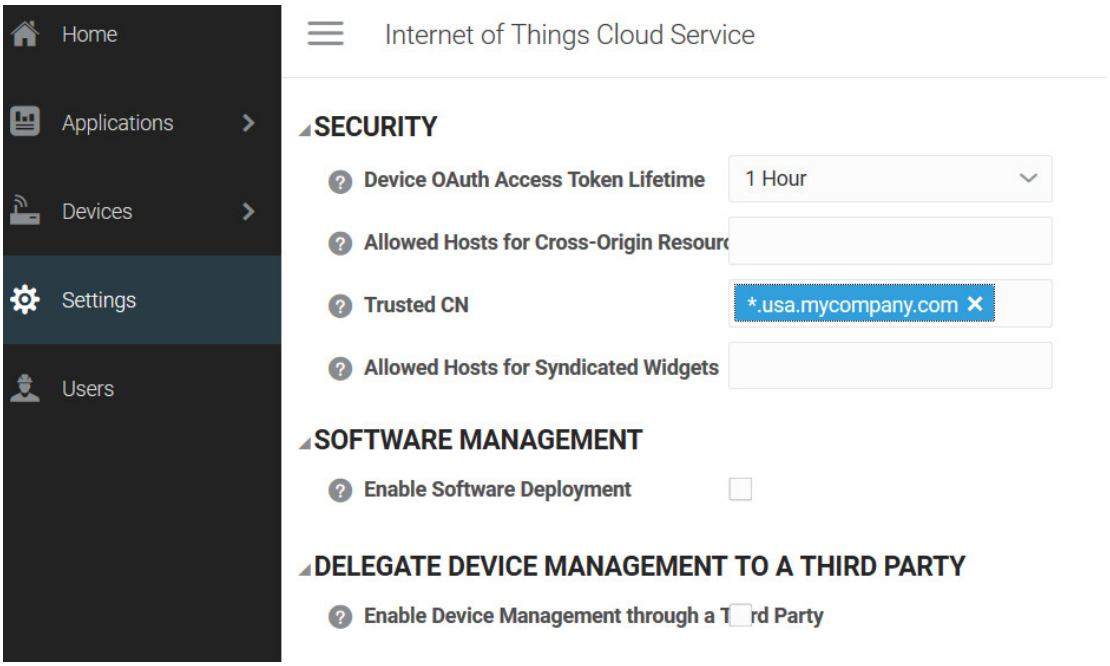
For detailed information on Analytics Cloud, refer to the Oracle Analytics Cloud Help Center Resources.

Add an Oracle Analytics Cloud Integration

Use the Integrations page in Oracle IoT Production Monitoring Cloud Service to add an integration for Oracle Analytics Cloud.

Before you configure Oracle Analytics Cloud integration, make sure your Oracle Analytics Cloud host is trusted by your Oracle Internet of Things Intelligent Applications Cloud domain.

Host names with `.oraclecloud.com` and `.oraclecloudapps.com` suffixes are always allowed. If your Oracle Analytics Cloud domain name is different, then add the domain as a trusted CN in the Oracle Internet of Things Intelligent Applications Cloud management console. To do this, add `*.YourDomain.com` under **Trusted CN** in the Settings page.



You can access your Oracle Internet of Things Intelligent Applications Cloud management console at the following URL:

`https://hostname/ui`

Here, *hostname* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

To enable integration with Oracle Analytics Cloud:

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.

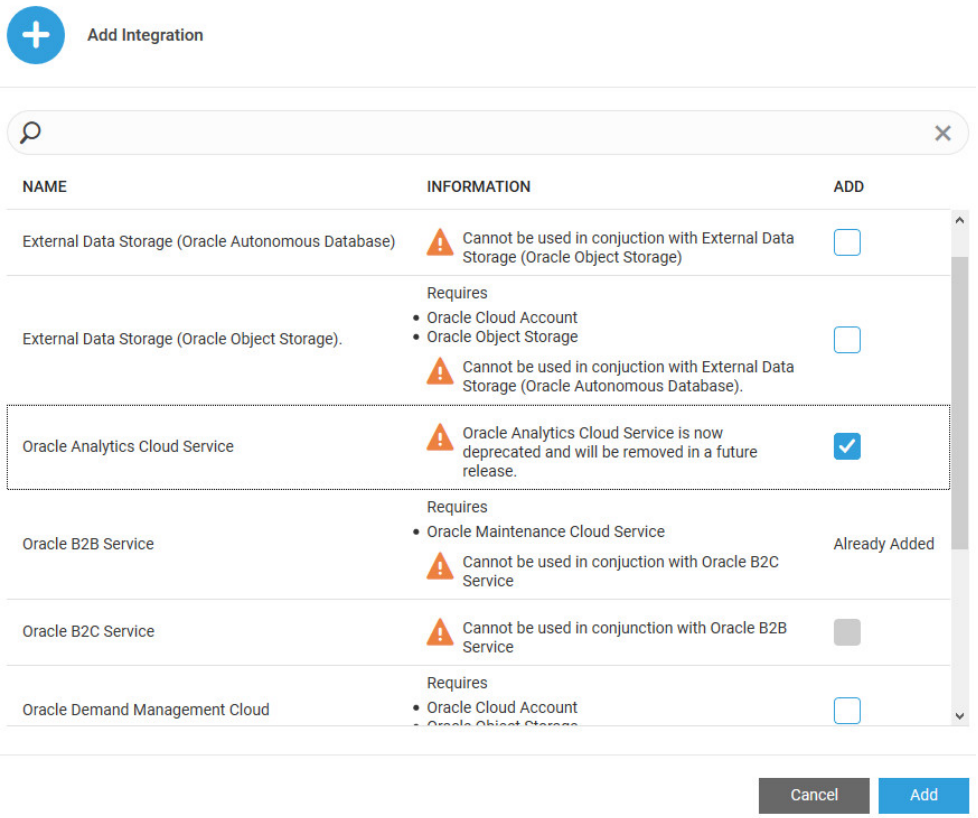
   You can access Oracle IoT Production Monitoring Cloud Service at the following URL:

   `https://hostname/pm`

   Here, *hostname* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

   If you are in the Design Center, you need to click **Previous** ( ) before you see the **Settings** option in the menu.
2. Click **Integrations**.
3. Click **Add** + to add a new integration.
4. In the Add Integration dialog, select **Oracle Analytics Cloud Service** and click **Add**.

   Tip: You can also search for an integration name in the list.



Oracle Analytics Cloud Service integration gets added to the Integrations page.

Enable and Configure the Oracle Analytics Cloud Integration

To start using Oracle Analytics Cloud integration, enable and configure the integration for **Oracle Analytics Cloud Service** on the Integrations page.

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** (☰), and then click **Settings**.
2. Click **Integrations**.
3. Under **Oracle Analytics Cloud Service**, select **Oracle Analytics Cloud Enabled**.
4. Specify the connection details for your Oracle Analytics Cloud instance.
   a. Specify the **Endpoint URL** for connecting to Analytics Cloud.

      Use the following format: `http://hostname:port`.

   b. Specify the **User Name** to connect to Analytics Cloud.
   c. Specify the **Password** for the Analytics Cloud user.
5. Click **Sync Data to OAC** to sync the factory, machine, and metric data with your Analytics Cloud instance.

   The **Sync Report** shows details on the status of the sync process.

The default sync interval between Oracle IoT Production Monitoring Cloud Service and Oracle Analytics Cloud is one hour. However, you can manually sync the data at any time.

6. (Optional) Under **Download OAC Project**, click **Download** if you wish to save a sample Analytics Cloud project that you can later import into your Analytics Cloud instance.

   The sample project contains sample data sets and visualizations based on the IoT factory, machine, and metric data.

   You can import the sample project into your Oracle Analytics Cloud instance to look at how the various IoT data sets can be joined, used to perform analyses, and create visualizations.

7. (Optional) Click **Download CSV Data** to download a zip file containing the `csv` (comma-separated value) files for your factory, machine, and metric data.

   You may want to download the `csv` data to keep historical records that you can later import and analyze in Analytics Cloud.

   You can import the `csv` files into your Analytics Cloud instance as data set files.

Import the Sample Project in Analytics Cloud

You can import the sample project downloaded from the Settings page in Oracle IoT Production Monitoring Cloud Service into Analytics Cloud.

1. If not done already, download the Analytics Cloud project file from the Integrations page of Oracle IoT Production Monitoring Cloud Service.

   Under Download OAC Project, click **Download**. See Enable and Configure the Oracle Analytics Cloud Integration for more information.

2. In Oracle Analytics Cloud, click **Page Menu** in the Projects page.
3. Click **Import.**
4. Select the `.dva` file that you downloaded from Oracle IoT Production Monitoring Cloud Service, and click **Import.**

   A confirmation message appears.

5. Double click the imported project on the Projects page to open it.

   You can next inspect the various data sets, calculations, data diagrams, and visualizations included in the project.

   For more details on working in Oracle Analytics Cloud, refer to the Analytics Cloud Documentation.

Create a New Project in Analytics Cloud Using IoT Data

After you have enabled Analytics Cloud integration in Oracle IoT Production Monitoring Cloud Service, you can use the synchronized factory, machine, and metric data sets to perform data analyses and create dashboards in Analytics Cloud.

1. From the Oracle Analytics Cloud home page, click **Create** and choose **Project.**

   You can also choose to click **Create** from the Project page.

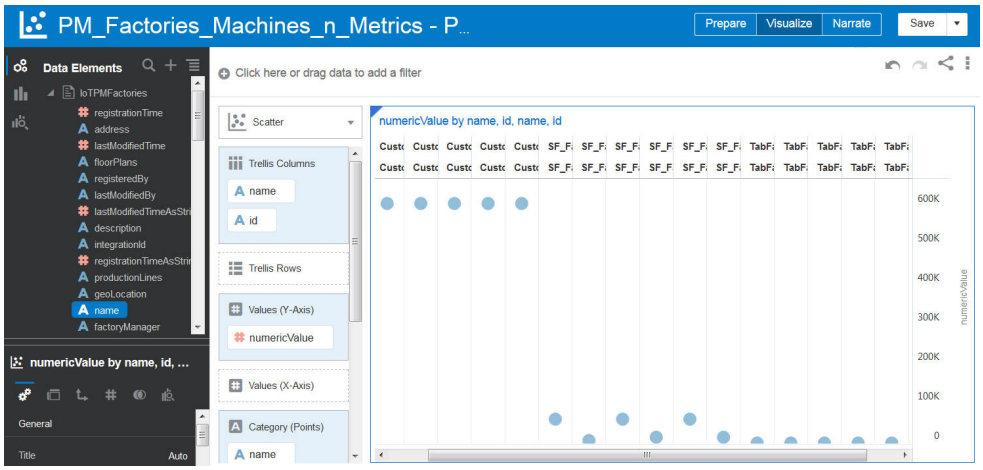
   The Add Data Set Dialog appears.

2. Choose one or more data sets synchronized from Oracle IoT Production Monitoring Cloud Service.

   The following data sets are available from Production Monitoring:

   - **IoTPMFactories**: Contains IoT factory data from your Oracle IoT Production Monitoring Cloud Service instance.
   - **IoTPMMachines**: Contains IoT machine data from your Oracle IoT Production Monitoring Cloud Service instance.
   - **IoTPMFactoryMetrics**: Contains IoT factory metrics data from your Oracle IoT Production Monitoring Cloud Service instance.
   - **IoTPMMachineMetrics**: Contains IoT machine metrics data from your Oracle IoT Production Monitoring Cloud Service instance.

3. Prepare your data and use the data to create visualizations and narrations.



You can create calculated columns in your data set tables. You can also create joins between two or more data set tables in Oracle Analytics Cloud to create visualizations on related data.

Refer to Oracle Analytics Cloud documentation for detailed information on Visualizing Data and Building Reports in Oracle Analytics Cloud.

Connect to External Systems

Connectors enable connectivity for devices or machines that cannot, otherwise, directly or indirectly connect to Oracle Internet of Things Intelligent Applications Cloud.

> **Note:**
>
> Connectors are currently available for testing purposes in development environments only, and are not available to be used in production environments.

For example, you may have IP devices without the appropriate protocols to use a client gateway, or you may have your own cloud service that contains all your device information.

If your machines and machine types are managed in an external system, such as OPC UA (OPC Unified Architecture), PI System, or MQTT, use the appropriate connectors in Oracle IoT Production Monitoring Cloud Service to connect to the external system, and to discover and import the machines and machine types into Oracle IoT Production Monitoring Cloud Service. The machine types and machines can be on-boarded automatically or manually. The associated device models are created based on the sensor attributes associated with your machines.

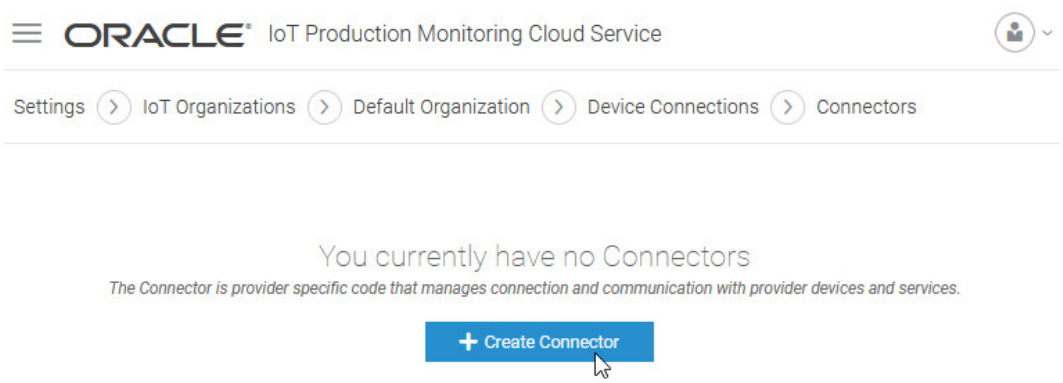
When manually on-boarding machine types, you can choose the machine types to on-board from the ones that are discovered. You can also choose the machine type attributes that you wish to include from the list of available attributes.

Once you add a machine to Oracle IoT Production Monitoring Cloud Service, the messages sent for the sensor attributes are received in Oracle IoT Production Monitoring Cloud Service.

Connect to an OPC UA Server

Use the OPC UA connector to connect to an OPC UA Server to discover machines and machine types, and to receive telemetry data.

1. Use the **Create Connector** option to create a connector from the **Menu >Settings > IoT Organizations > *Organization Name* > Device Connections > Connectors** page.



2. Under **Type**, choose **OPC UA** and click **Create**.
3. Enter a **Name** and optional **Description** for the new connector.
4. Select an onboarding mode:
   - **Automatic:** All machine types and machines discovered on the external server are automatically added in Oracle IoT Production Monitoring Cloud Service.
   - **Manual:** Enables you to choose the machine types to add from the list of discovered machine types. The manual mode also lets you select the machine attributes that you want from the ones available in the discovered machine type.
5. Enter **Connection** and **Authentication** details for your OPC UA server.
   - **URL**: Enter the URL for your OPC UA server.

- **User Name**: Enter the user name to log in to the OPC UA server.
- **Password**: Enter the password for the OPC UA user.

6. Under **Target** select the **Factory ID** for the factory to which the machine types and machines belong.
7. Click **Save** to save the connector.

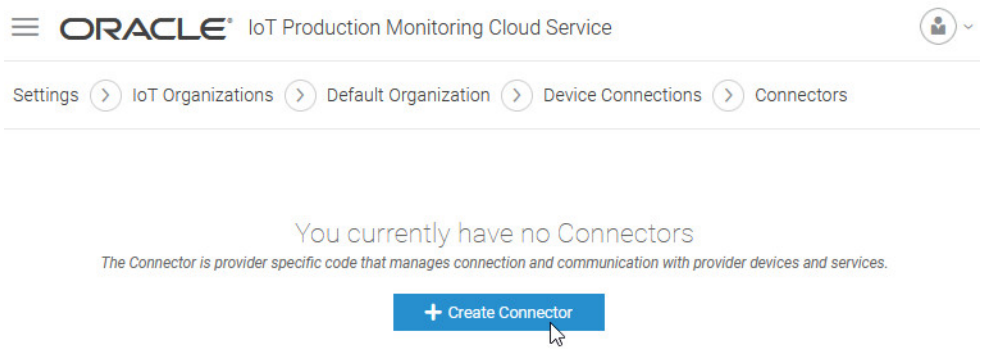
The connector next starts, and you should start seeing discovered machines and machine types on the Notifications page for the connector. If you have chosen the automatic mode, the machine types and machines are already added to the selected factory in Oracle IoT Production Monitoring Cloud Service. If you have chosen the manual mode, then you can choose the machine types and attributes to add from the connector Notifications page.
The following tutorials contain more information on OPC UA:

- Create and Manage the OPC UA Connector in Oracle IoT Production Monitoring Cloud Service
- Configure Oracle IoT OPC UA Gateway Software to Integrate with OPC UA Server

Connect to a PI Server

Use the PI System connector to connect to a PI Server to discover machines and machine types, and to receive telemetry data.

1. Use the **Create Connector** option to create a connector from the **Menu >Settings > IoT Organizations > *Organization Name* > Device Connections > Connectors** page.



2. Under **Type**, choose **PI System** and click **Create**.
3. Enter a **Name** and optional **Description** for the new connector.
4. Select an onboarding mode:
   - **Automatic:** All machine types and machines discovered on the external server are automatically added in Oracle IoT Production Monitoring Cloud Service.
   - **Manual:** Enables you to choose the machine types to add from the list of discovered machine types. The manual mode also lets you select the machine attributes that you want from the ones available in the discovered machine type.

5. Enter **Connection** and **Authentication** details for your PI Server.
   - **PI Server**: Enter the host name for your PI Server.
   - **User Name**: Enter the user name to log in to the PI Server.
   - **Password**: Enter the password for the PI Server.
6. Under **Target**, select the **Factory ID** for the factory to which the machine types and machines belong.
7. Click **Save** to save the connector.

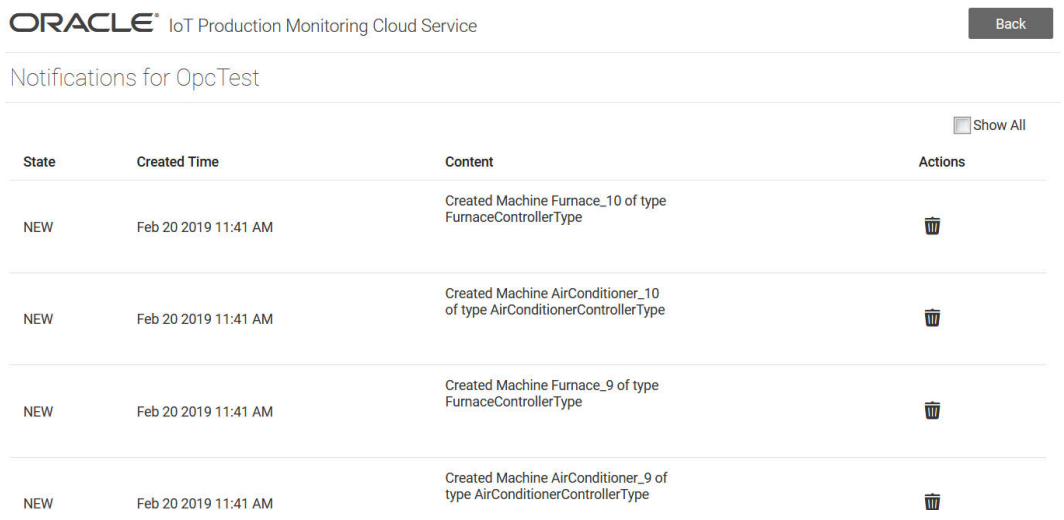
The connector next starts, and you should start seeing discovered machines and machine types on the Notifications page for the connector. If you have chosen the automatic mode, the machine types and machines are already added to the selected factory in Oracle IoT Production Monitoring Cloud Service. If you have chosen the manual mode, then you can choose the machine types and attributes to add from the connector notifications page.
The following tutorial shows you how to install, configure, and run the Oracle IoT PI System Gateway software that integrates a PI System server with the Oracle Internet of Things (IoT) Production Monitoring Cloud Service application:
Configure Oracle IoT PI System Gateway Software to Integrate with PI System

View and Act on Connector Notifications

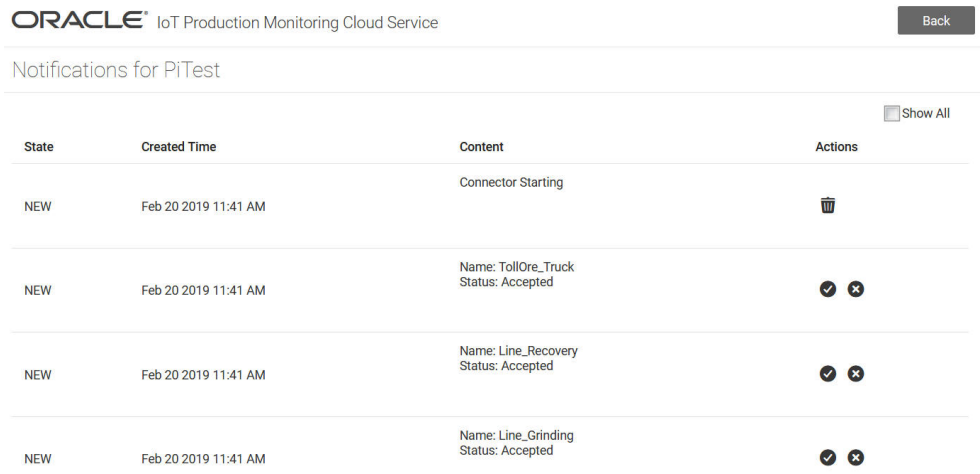
Use the connector Notifications page to view notifications on machines and machine types discovered by the connector. For manual onboarding, you can select the machine types and machine attributes that you wish to accept.

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Organization** from the **Design Center** sub-menu.
3. Click **Device Connections**.
4. Click **Notifications** against your connector row to open the Notifications page for the connector.

   The Notifications page shows notification messages for the machine types and machines that were discovered by the connector.



5. If you have chosen manual on-boarding for your connector, choose the machine types to add from the list of discovered machine types.



   a. Click **Accept** against the discovered machine type to add the machine type to Oracle IoT Production Monitoring Cloud Service.

      A list of available attributes for the machine type appears.

   b. Use the toggle buttons to select or deselect attributes for the machine type.

   c. Click **Accept**.

      The machine type, together with any discovered machines, is added to Oracle IoT Production Monitoring Cloud Service.

6. Click **Back** to return to the Connectors page.

You may verify the added types and machines under the Machine Type and Machine pages.

11

Simulate Factory Operation

Use simulations to test Oracle IoT Production Monitoring Cloud Service or to demonstrate its features.

Topics

- How to Simulate Your Factory Operation
- How to Access the Production Monitoring Simulator
- Create Predefined Factory Models
- Simulate the Operation of the Machines in Your Factory
- Simulate Sensor Data
- Export Factory Models
- Import Factory Models
- Create a Custom Factory Model

How to Simulate Your Factory Operation

Use the Oracle IoT Production Monitoring Cloud Service simulator to create factories and simulate their operation for testing purposes or demonstrations.

The simulator lets you define a factory model that contains a group of factories that you will use for your simulator. You can define the factory model in the following ways:

- Use a predefined factory model: choose one of the available predefined factory models included in the simulator. See Create Predefined Factory Models.
- Import an factory model that you exported from another simulator instance of this same instance at a previous time. See Import Factory Models.
- Create a custom factory model: define your own factory mode. Manually specify the machine types, device models, products, product routing, and machines to use in your simulation.

You can view the factories you create with the simulator in your instance of Oracle IoT Production Monitoring Cloud Service. Use the simulator to change the behavior of the factories, its machines, and sensors. See Simulate Factory Operation, Simulate the Operation of the Machines in Your Factory, and Simulate Sensor Data.

How to Access the Production Monitoring Simulator

Log in to the simulator to generate data that simulates the operation of your factories in Oracle IoT Production Monitoring Cloud Service.

To log in to the simulator you must have a user account in Oracle IoT Production Monitoring Cloud Service. Oracle provides user account information when you subscribe to the cloud service.

1. Open an internet browser and go to: `https://hostname/pm-sim`

   You can find the name of your host in the email you received when you subscribed to the service.
2. Enter your user name and password.
3. Click **Sign In**.

The **Simulations** page appears. If this is the first time you are using the simulator, the list of factory models is empty. For information on how to create a factory model, see Create Predefined Factory Models and Create a Custom Factory Model.

Create Predefined Factory Models

Run your simulation using one of the predefined factory models included in the simulator. Predefined factory models are simple and quick to configure.

Create the predefined factory model:

1. In the simulations page, click **Add Factory Model** + .
2. Click a predefined factory model.

   The available predefined factory models are: **Chocolate Factory** and **Tablet Factory**.

   The predefined factory model is created. A message in the status bar located below the list of factory models, indicates if the creation was successful.

   By default, the factory model has no factories associated.

Create and associate factories:

3. Click the name of a factory model.
4. For each factory that you want to add:

   a. Click **Create Factory** + .
   b. (Optional) Expand **Customize** and provide the name, description, and GPS coordinates for your factory.
   c. Click **Create**.
   d. Click the **Stopped** icon in the **Running** column, to start simulating the production for this factory.

      The icon you clicked becomes a **Running** icon to indicate the factory is now running. To stop the simulation for this factory, click this icon.

The factories you add to the predefined factory model appear in your instance of Oracle IoT Production Monitoring Cloud Service. Each factory contains set of machines. You can simulate the operation of the machines in your factory, see .

The simulator automatically creates a production plan for the new factory and its machines based on the daily plan values associated with each machine.

Simulate the Operation of the Machines in Your Factory

Modify the behavior of the machines in your factory to simulate a production issue.

1. In the list of factories for a factory model, click the **View** icon for your factory.

   The list of machines for that factory appears.
2. For each of the machines in the list you can:
   - Change the status of the machine: click one of the available status options for this machine. The available options are **Idle**, **In Use**, and **Down**.
   - Trigger the events associates to the different sensors for this machine: select an event from the **Events** column. Some sensors may support multiple events.

Simulate Sensor Data

Monitor the data from the sensors in your factory and trigger events to simulate production issues or trigger notifications. You can also turn the sensor off.

1. In the **Factory** page, click the **Device ID** for the sensor and machine that you want to monitor.
2. For each sensor you can perform the following actions:
   - Trigger events: if the sensor defines events, select an event from the **Events** list in the **Controls** section.
   - Monitor status: use the **Device Status** tab to monitor the status for this sensor. Click the **Data Chart** tab to view the values for this sensor in the last minute.
   - Tun the sensor on /off: click the **Status** toggle button located in the **Device Monitoring** section.

Export Factory Models

Export factory models to back up your simulation, or to use them in a different instance.

1. Click **Menu** and then select **Simulations**.
2. Click the name of the factory model that you want to export.
3. Click **Export Factory Model**.

   A zip file with the name of your factory is saved to your Downloads folder.

The exported file contains the factories in your factory model as well as the associated products, machine types, routing tasks, device models, and sensor simulation models. To import an exported file, see Import Factory Models.

Import Factory Models

Import factory models that were exported from another instance, or they are a backup of factory models from your current instance.

To import a factory model you must provide a zip file with an exported factory model. For more information on how to export a factory model, see Export Factory Models.

1. Click **Menu** and then select **Simulations**.

2. Click **Add** + .
3. Select **Import**.
4. Browse to the location of your exported file and select it.

The simulator and your instance of Oracle IoT Production Monitoring Cloud Service now contain the factories in your factory model as well as the associated products, machine types, routing tasks, device models, and sensor simulation models.

Create a Custom Factory Model

Create a factory model that uses specific devices, machines, product routing, and manufactures a specific product. Use custom factory models for detailed testing or for demonstrating a specific use case.

Create and register the device models that you will use in your custom factory model:

1. In the Oracle Internet of Things Intelligent Applications Cloud **Device Simulator**, create the simulation and device models to support your factory model.

   See Creating a Simulated Device in Oracle Internet of Things Intelligent Applications Cloud Device Simulator.

2. In the Oracle Internet of Things Intelligent Applications Cloud **Management Console**, register the device models you created.

   See Registering a Device.

Use Oracle IoT Production Monitoring Cloud Service to create the business entities to support your factory model:

3. Create a machine type for the device models you created.

   See Create Machine Types.

4. Create the product your factories will manufacture.

   See Create Products.

5. Upload the product routing.

   Upload Production and Maintenance Data

Create the custom factory model:

6. Click **Menu** ☰ and then select **Simulations**.
7. Click **Add** + .
8. Select **Custom**.
9. Enter a name to identify this factory model.
10. (Optional) In the **Messaging Interval** field, specify the amount of time to wait before sending a new data message.
11. For each production line you want to simulate in your factory model, click **Add Production Line** and enter a name to identify the production line.
12. For each machine type you want to simulate in your factory model, click **Add Machine Type** and select a machine type.

13. For each product you want to manufacture in your factory model, click **Add Product** and select a product from the **Product ID** list.

    When you select a product the corresponding product routing appears.

14. Assign the different routing tasks to a production line.
15. Assign machines to perform the different routing tasks:
    a. Click **Add Machine**.
    b. From the **Machine Type** list, select a machine type.

       This lists shows the machine types that you added before.

    c. In the **Number of Machines** column, enter the number of machines you are adding.
    d. In the **Production Cycle Time** column, enter the time this machine takes to complete a production cycle.
    e. In the **Daily Plan** column, enter the number of units that you expect this machine to produce in a day.
16. Click **Save**.
17. Click **Close** to close this page.
18. Click the name of the custom factory model you just created.
19. For each factory you want to add to your factory model:
    a. Click **Create Factory** .
    b. (Optional) Expand **Customize** and provide the name, description, and GPS coordinates for your factory.
    c. Click **Create**.
    d. Click the **Stopped** icon in the **Running** column, to start simulating the production for this factory.

       The icon you clicked becomes a **Running** icon to indicate the factory is now running. To stop the simulation for this factory, click this icon.

12

Upload Your Data

Upload existing data from third party systems and industrial systems, or manually create business entities and upload data using CSV files or REST APIs.

Topics

- How to Upload Your Data
- Create Factories
- Create Machine Types
- Create Machines
- Create Products
- Upload Production and Maintenance Data
- Understand Production and Maintenance Data

How to Upload Your Data

Upload data to Oracle IoT Production Monitoring Cloud Service using different methods according to the nature of your data.

Before your users can start using the application you must upload data for all the factories you want to monitor.

You can upload data in the following ways:

- Read data from third party systems using the REST API for Oracle IoT Production Monitoring Cloud Service.
- Read data from industrial systems that use the OPC-UA standard.
- Manually create the business entities and upload maintenance and production data using CSV files.

  Typically you create data manually when you are testing or preparing the product for a demo, or if your factory is small or you are only uploading a part of the data.

  For information about how to create the business entities, see Create Factories, Create Machine Types, Create Machines, and Create Products.

  For information on how to upload data using CSV files, see Upload Production and Maintenance Data.
- Create business entities and upload data using REST API for Oracle IoT Production Monitoring Cloud Service.

Create Factories

Manually upload the data for a new factory. You can also upload the factory floor plan.

1. Click **Menu** and then click **Design Center**.
2. Select **Factories** from the **Design Center** menu.
3. Click **Add** .
4. Enter an ID to identify the factory.

   You can't use the same ID for different factories.
5. Enter the name of the factory.

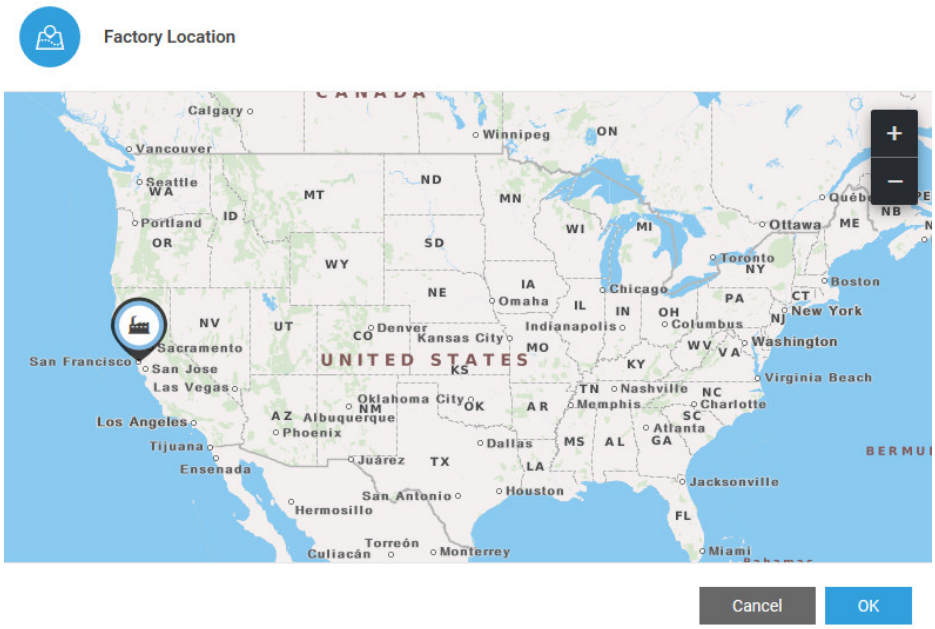
   The Map View displays this name below the factory icon. The Design Center also uses the name to identify the factory.
6. (Optional) Enter a description.
7. Enter the location details for your factory.

> **Note:**
>
> You can also add or update the location later by selecting the factory in Design Center and clicking **Location**.

   a. (Optional) Enter the address of your factory.

      For example: 14420 Network Circle, Santa Clara, CA 95054.

   b. (Optional) Enter the **Latitude** and **Longitude** coordinates for your factory, so that your factory appears in the map view. Alternatively, click **Factory Location** and select the factory location on the map.



8. (Optional) Enter the contact information for the factory manager.

9. (Optional) Add a factory floor plan:

> **Note:**
>
> You can also add or update a floor plan later by selecting the factory in Design Center and clicking **Floor Plans**.

   a. Click **Floor Plan** .
   b. (Optional) **Select Enable Geo-location Support** if you wish to support moving machines, such as robots, that dynamically report their locations on the floor plan.
   c. Click **Add** (**+**), and select an existing image file for your factory floor plan.
   d. If you previously selected the option to enable Geo-location support, then click **Set Reference Points** to specify two sets of latitude and longitude reference points on your floor map.
   e. Specify the reference point coordinates and click **OK**.

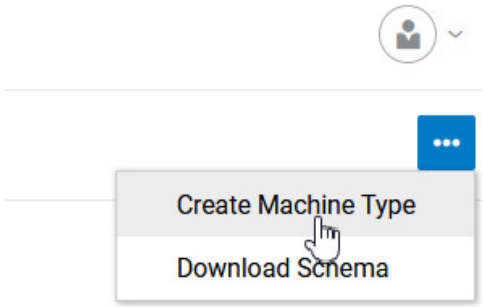
      You can zoom in or zoom out the plan and drag the reference points to the desired location before specifying your coordinates.

10. Click **Save** to save the new factory.
11. Click **Close** (**X**) to return to the **Factory** list.

Create Machine Types

Create a machine type, and specify common attributes applicable to all machines of the machine type. Also, create sensor attributes that will map to your device sensor attributes.

1. Click **Menu** (), and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** sub-menu.
3. Select **Create Machine Type** from the **Machine Types** menu.



4. Enter a **Name** and an optional **Description** for the machine type.

   Do not use spaces or special characters in the **Name** field. If you add spaces or special characters, an error message appears.

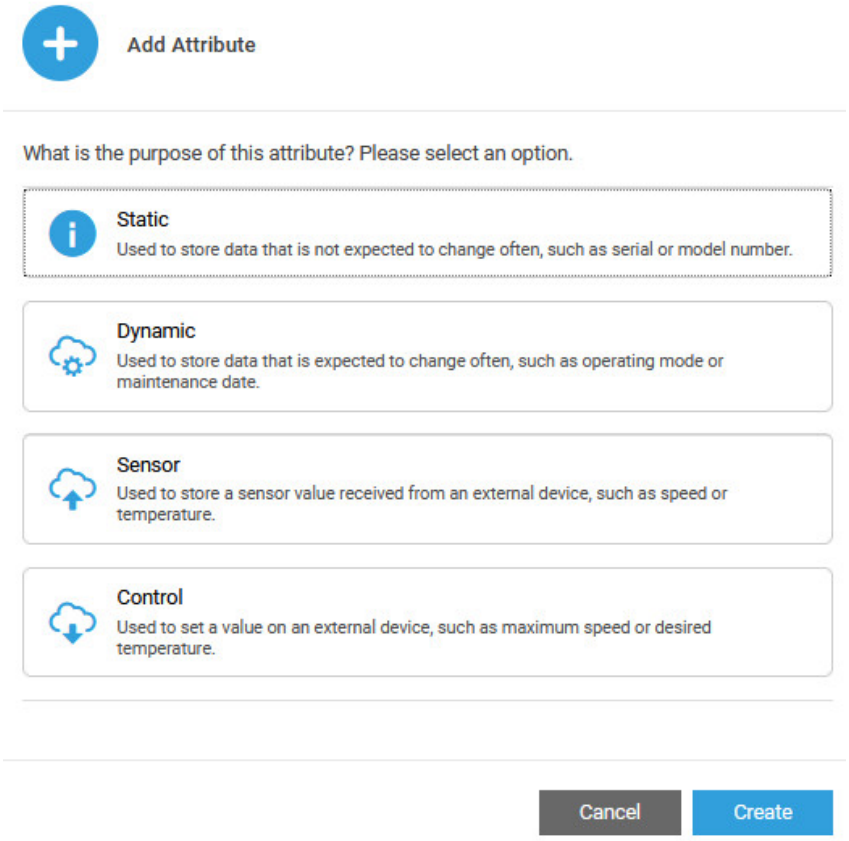
5. (Optional) Click **Upload Icon** to upload an icon for the machine type.

An icon makes it easier to quickly identify the machine type in the map view.

6. Add any required and optional attributes for the machine type:

   a. Click **Add Attribute** (+) to add a new attribute.

   b. Select the attribute type.



- Custom Attributes: A custom attribute is specific to the machine type, such as a *model number* for a *vehicle*. Custom attributes are not associated with machine sensors. Custom attributes can be of the following types:
  - **Static:** Static custom attributes are used to store data that is not expected to change often, such as the serial or model number of a machine.
  - **Dynamic:** Dynamic custom attributes can change often, such as the operating mode or maintenance date for a machine. You can use the operations center, or automatic action-based rules to update the dynamic attribute values.
- **Sensor:** A sensor attribute corresponds to a device sensor value. For example, a packaging machine might support temperature and vibration sensors. Note that the actual linking to the device happens when you create the machine.
- **Control:** A control attribute lets you send data back from your digital twin to the actual device. Use control attributes to set the actuator attribute

values for your IoT devices. For example, if a motor supports the *Overheat* attribute, you can set the attribute from your IoT application.

> **Note:**
>
> Control attributes can be currently used for sending MQTT data back to devices using direct ingestion.

c. Specify a **Name** for the attribute.

d. (Optional) Add a **Description** about the attribute.

e. (Optional) Choose a **Category** if available.

   By default, the UNCATEGORIZED category is used. You can choose to rename the category from the Attributes page.

f. Select whether the attribute is **Required** or optional.

   You must specify a value for a required attribute when instantiating a machine type to create a machine.

g. Choose a data **Type** for the attribute.

   This field is only applicable to custom and sensor attributes. You can select between text, number, date, boolean, and image data types.

h. (Optional) For static and dynamic attributes, specify a **Default** value of the attribute.

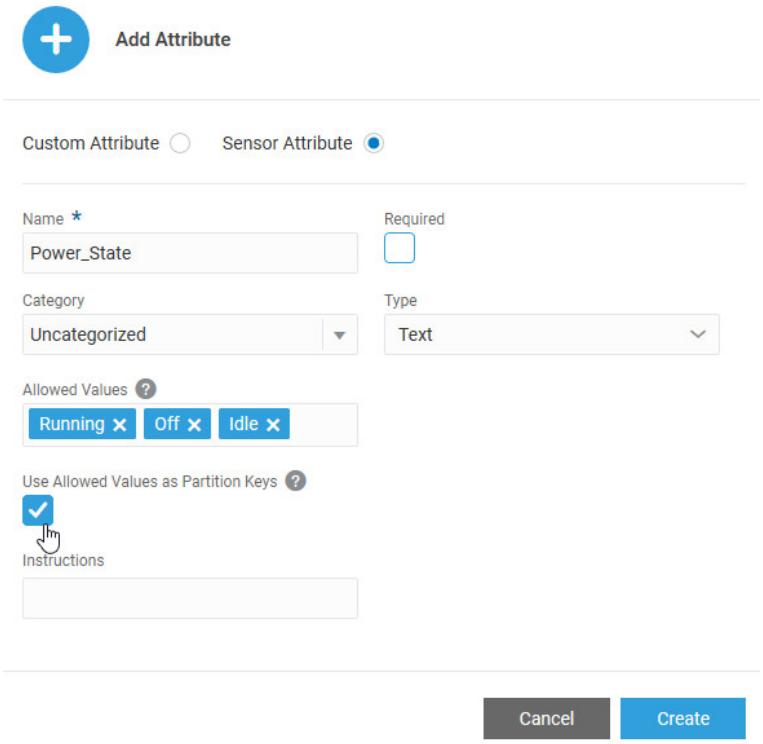
   This field is only applicable to custom attributes. If you do not specify an attribute value when creating a machine, the default value is used.

i. (Optional) You can specify a list of **Allowed Values** for your attribute.

   Press **Enter** after entering each value.

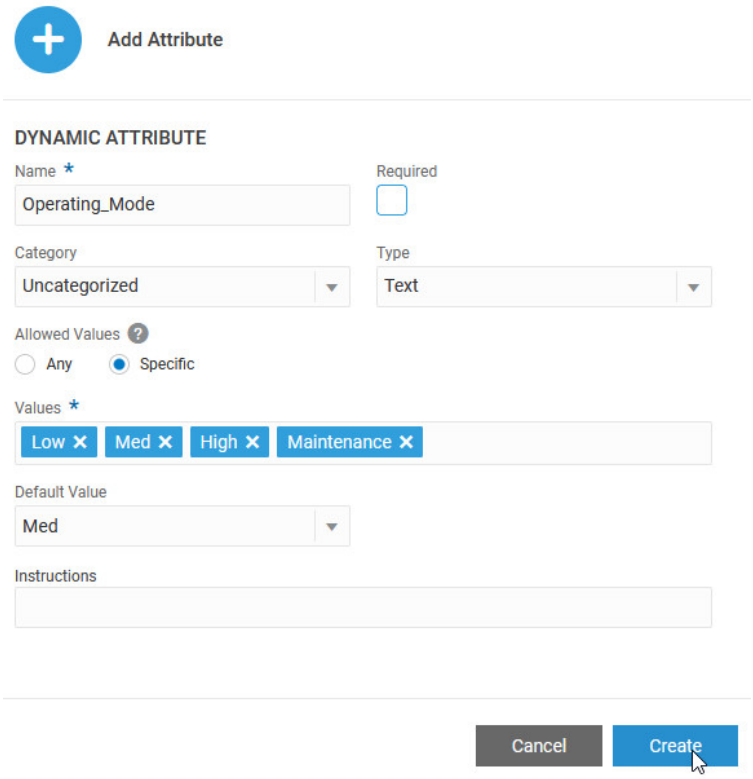
   Some attribute types, such as Number, also allow you to specify a range of allowed values.

j. (Optional) For sensor attributes, if you have used the **Allowed Values** field, you can optionally choose **Use the Allowed Values as Partition Keys**.



Select this option if you intend to use the allowed values as partition keys in your state-aware anomalies. See Define an Automatic Anomaly for more information.

The following example shows a dynamic attribute, `Operating_Mode` that has predefined modes of operation. A default operating mode is also selected.



k. Click **Create**.

l. Repeat the above steps to create additional attributes.

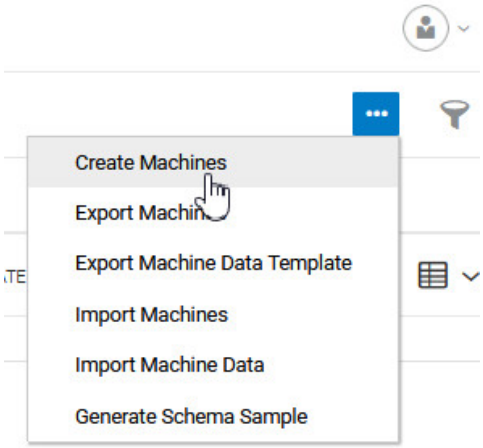
7. Click **Save** and then click **OK**.
8. Close the window to return to the **Machine Types** list.

Create Machines

Manually upload the data for the machines in your factories.

Before creating a machine, you must define the machine type for this machine. See Create Machine Types.

1. Click **Menu** and then click **Design Center**.
2. Select **Machines** from the **Design Center** menu.
3. Click the **Machine Inventory Menu** and select **Create Machines**.



4. To create a single machine, click **Create Single Machine**.
5. Select the **Entity Type** (Machine Type) for the machine.

   The Machine Type must already exist in the application.
6. From the **Factories** list, select the factory where your machine is located.
7. Enter a **Name** for the machine.

   The application creates a default name for the new machine. You can choose to change this to a name meaningful for your environment. Default names are especially useful when creating machines in bulk.
8. (Optional) Select the **Data Source** for the machine sensor attributes.

   If you are using direct data ingestion for your device, you can choose to specify the direct data source details here.

> **Note:**
>
> You can also choose to specify the data source for your sensor attributes in the machine editor after creating the machine.

- **Direct:** Use for devices that can directly connect with the application.
  - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.
  - **Authentication:** Select between **Client Certificate** and **Client ID/Secret**.

    Client certificate is the recommended option for increased security. The default **Common Name** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the common name.

    If using **Client ID/Secret**, specify a secure password in the **Secret** field. The default **Client ID** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the client ID.
  - **Payload:** Select **Schema** if you are using the standard schema format for data ingestion. Select **Custom** if the payload does not follow the schema.

If choosing the custom option, you must specify a previously created **Interpreter** to interpret the payload.

- **Direct via Any Connector:** Use for devices that connect using a connector.

  External ID: You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

- **Direct via Specific Connector:** Use for devices that can connect using the specified connector.
  - **Connector:** Select a connector that you have previously created.
  - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

9. Click **Create** to continue create the machine.

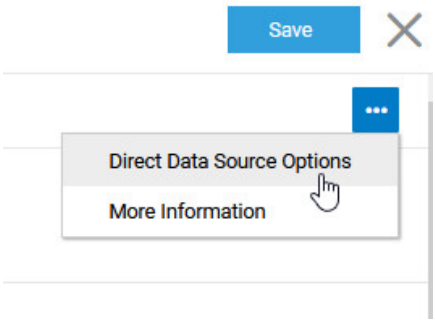
   The machine editor opens up where you can edit the machine details and finalize the data sources for your sensor attributes.

10. Select the **Data Source** for the machine sensor attributes.
    - **Direct:**
      Select if you are ingesting IoT data from directly connected devices, gateways, and network servers directly into your machine sensor attributes. Choose direct ingestion to eliminate the need for registering devices and device models, and for creating IoT messages.
    - **Linked Device:**
      Select to link to an IoT device registered with Oracle Internet of Things Intelligent Applications Cloud.

11. Depending on your choice in the preceding step, complete the direct data source settings, or complete linking the sensor attributes to your device attributes.

    If you selected **Direct** under **Data Source**, complete the direct data source settings:

    a. Select **Direct Data Source Options** from the editor menu.



    b. Select the **Data Source**:
       - **Direct:** Use for devices that can directly connect with the application.
         - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.
         - **Authentication:** Select between **Client Certificate** and **Client ID/Secret**.

Client certificate is the recommended option for increased security. The default **Common Name** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the common name.

If using **Client ID/Secret**, specify a secure password in the **Secret** field. The default **Client ID** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the client ID.

- **Payload:** Select **Schema** if you are using the standard schema format for data ingestion. Select **Custom** if the payload does not follow the schema. If choosing the custom option, you must specify a previously created **Interpreter** to interpret the payload.

- **Direct via Any Connector:** Use for devices that connect using a connector.

  External ID: You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

- **Direct via Specific Connector:** Use for devices that can connect using the specified connector.
  - **Connector:** Select a connector that you have previously created.
  - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

c. Click **OK** in the Direct Data Source Options dialog.

   See Use Direct Data Ingestion for Your Sensor Attributes for detailed information and examples on using direct data ingestion for your machine attributes.

If you selected **Linked Device:** under **Data Source**, complete linking the sensor attributes to the registered device attributes:

A sensor attribute lets you link to an IoT device sensor. For successful linking, the IoT device should be already present in Oracle Internet of Things Intelligent Applications Cloud, and the corresponding device model should have been selected for the Oracle IoT Production Monitoring Cloud Service application.

a. Click **Link to Device** ( ) against a sensor attribute.

b. Select from the list of available devices.

   For successful linking, the IoT device should be already present in Oracle Internet of Things Intelligent Applications Cloud, and the corresponding device model should have been selected for the Oracle IoT Production Monitoring Cloud Service application.

   You can use **Select Filter** to filter the available devices, say by device name or serial number.

c. Under Sensor Attribute Binding, confirm that the correct **Device Model/URN** is displayed.

d. Select the **Device Attribute** that corresponds to the sensor attribute.

e. Click **Select**.

   The sensor attribute is now linked to your IoT device attribute.

12. Add your machine to the factory floor plan:
    a. Click **Floor Plan** .
    b. Zoom in our out to view the location where you want to place the machine.
    c. Drag the machine icon to the desired location on the factory floor plan.
13. Click **Save**.
14. Close the editor to return to the Machine Inventory page.

Create Machine Clusters Based on Attribute Behavior

The IoT application can automatically cluster entities based on attribute behavior. You can choose to create a clustering configuration for a machine type. This lets IoT group entities with similar attribute behavior over the specified data window.

For example, say you have a temperature sensor entity-type, but different sensors have different normal temperature ranges, depending on whether the sensor is being used to measure ambient temperature or furnace temperature. A cluster is able to separate the ambient sensor entities from the furnace sensor entities.

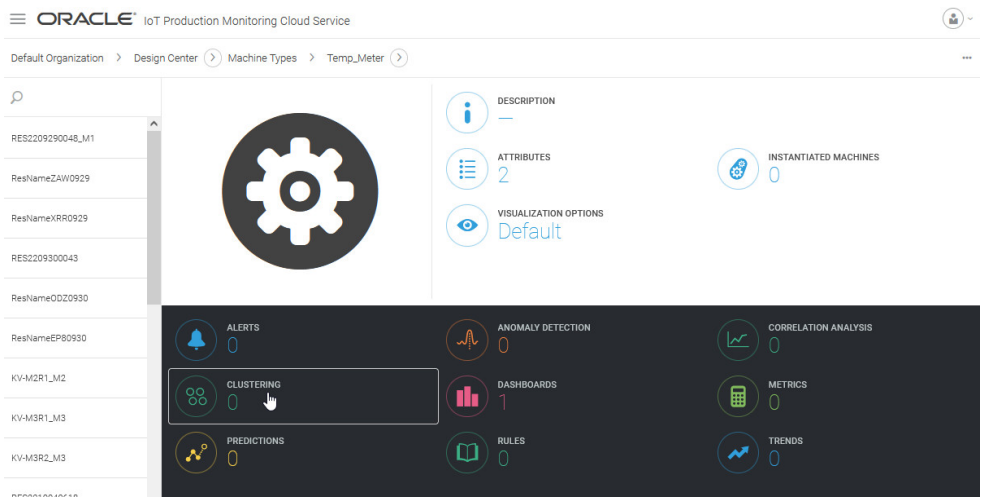
The **Clustering** tab in Operations Center shows you the details on the clusters, including sensor values and the cluster memberships that the application creates. You can also visualize the tightness of each cluster, and the distances between individual clusters.

Create Clustering Configuration for a Machine Type

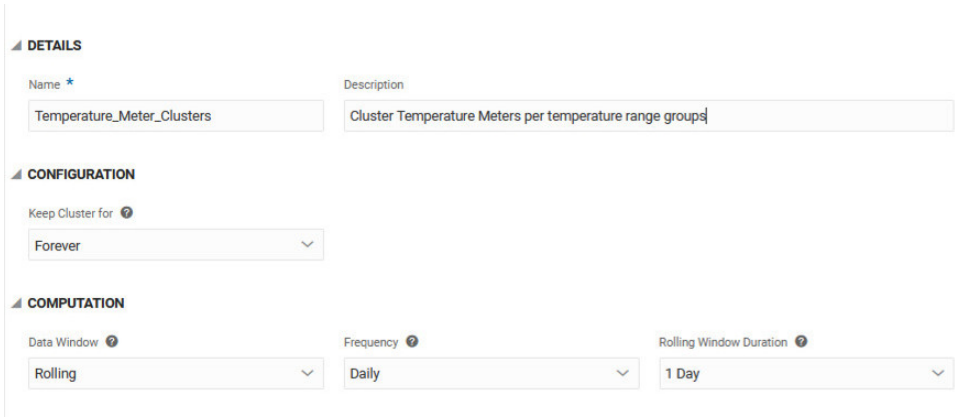
Create a clustering configuration to automatically group machines into clusters based on machine attribute behavior. You can specify a static or rolling data window to train the system for machine grouping.

1. Click **Menu** (), and then click **Design Center**.
2. Select **Machine Types** from the **Design Center** sub-menu.
3. Select a machine type from the **Machine Types** list.

   You can also search for a machine type.
4. Click **Clustering**.



5. Select **Create Clustering Configuration** from the page menu .
6. Under the **Details** section, provide a **Name** and **Description** for the clustering configuration.



7. Under **Configuration**, specify the duration for which to keep the cluster configuration.

   The default setting **Last Value Only** stores only the last known configuration.

   If you have unique storage requirements for historical data related to this cluster, you can select an option that is different from the default setting.
8. Under **Computation**, specify a **Data Window** for training the cluster configuration.

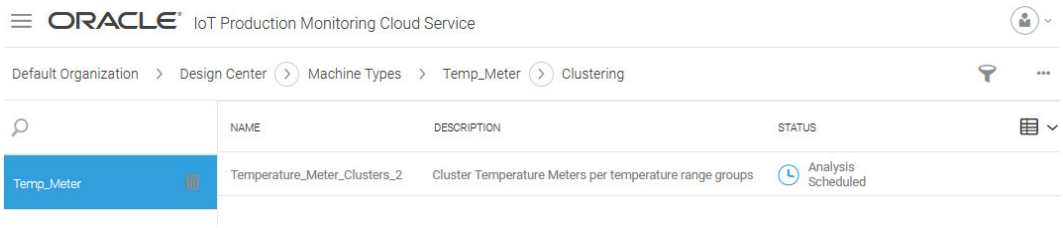
   The **Data Window** identifies the historical data that is used to train the system for creating clusters. Machine data collected over the data window is used to determine the clusters.

   - **Rolling**: A rolling data window uses data from a rolling time window to pick the most recent data for training. For example, you can choose to train your cluster configuration with a rolling data window of the last 7 days, and choose to perform the training daily.
     When you use a rolling window, the training model is re-created periodically, as determined by the frequency that you choose.

  - **Frequency**: You can optionally change the frequency of the cluster configuration training. For example, if you choose **Daily**, then the training happens every day at 00:00 hours (midnight), UTC time by default.
  - **Rolling Window Duration**: The duration of the rolling window going back from the model training time. For example, if you select **7 Days**, then the last 7 days of target attribute data is used to train the cluster configuration.
- **Static**: Uses a static data window to train your cluster configuration. Select the **Window Start Time** and **Window End Time** for your static window period. The static data window provides data for a one-time training of your cluster configuration. If your cluster accuracy changes in the future, you should edit the cluster configuration to choose a different static window.

9. Click **Save** to create the cluster configuration.

   The system now schedules analysis for the new cluster configuration.

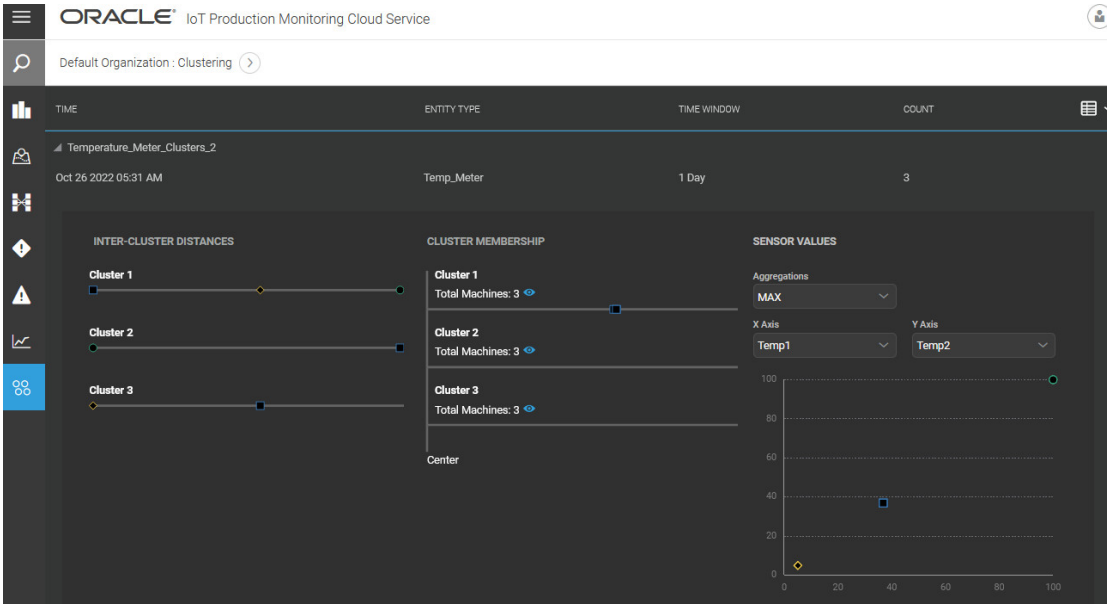


The clusters start appearing in Operations Center once the analysis is complete.

View Machine Clusters in Operations Center

The **Clustering** tab in Operations Center shows you the details on the clusters, including sensor values and the cluster memberships that the application creates. You can also visualize the tightness of each cluster, and the distances between individual clusters.

The clusters are shown at the organizational level in Operations Center.



The cluster membership rows are ordered by cluster size.

An Inter-Cluster Distances pane appears if there are three or more clusters

You can also plot and compare aggregated values (**Max, Min, Sum, Average**) of sensor attributes for each cluster.

Use Direct Data Ingestion for Your Sensor Attributes

Your digital twin entities are now directly addressable over the network, using standard protocols, authentication mechanisms, and payload formats. Ingest IoT data from directly connected devices, gateways, and network servers directly into your asset and machine sensor attributes.

Choose direct ingestion to eliminate the need for registering devices and device models, and for creating IoT messages.

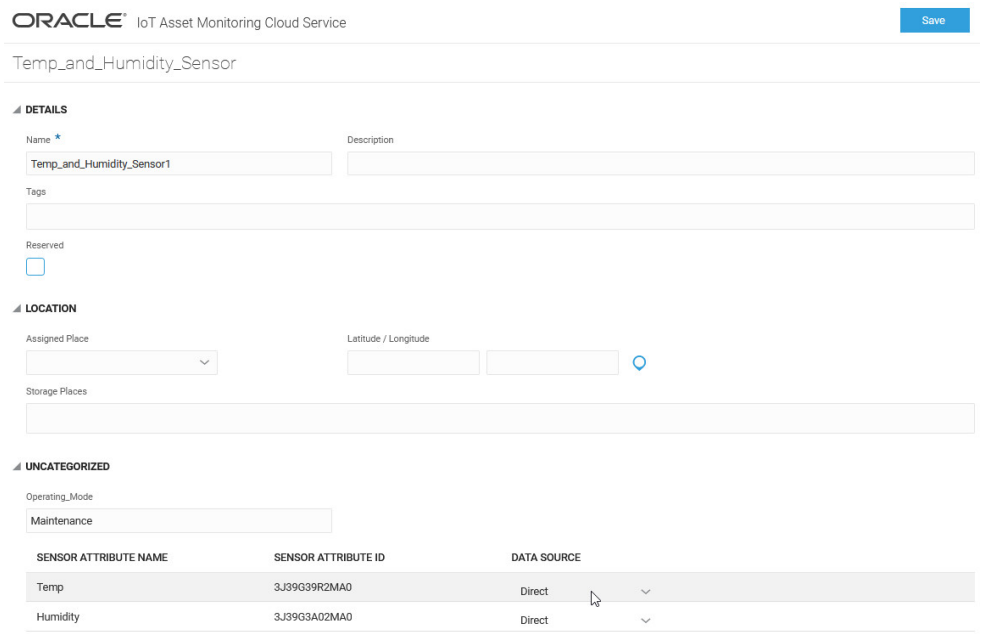
Use standard HTTP or MQTT protocol to send sensor data in JSON or CSV format. The application supports mutual authentication using certificates in addition to basic authentication.

The application lets you download ready-to-use schema samples for your entities. If you have custom payloads, use the interpreter editor interface to create the mappings and routing.

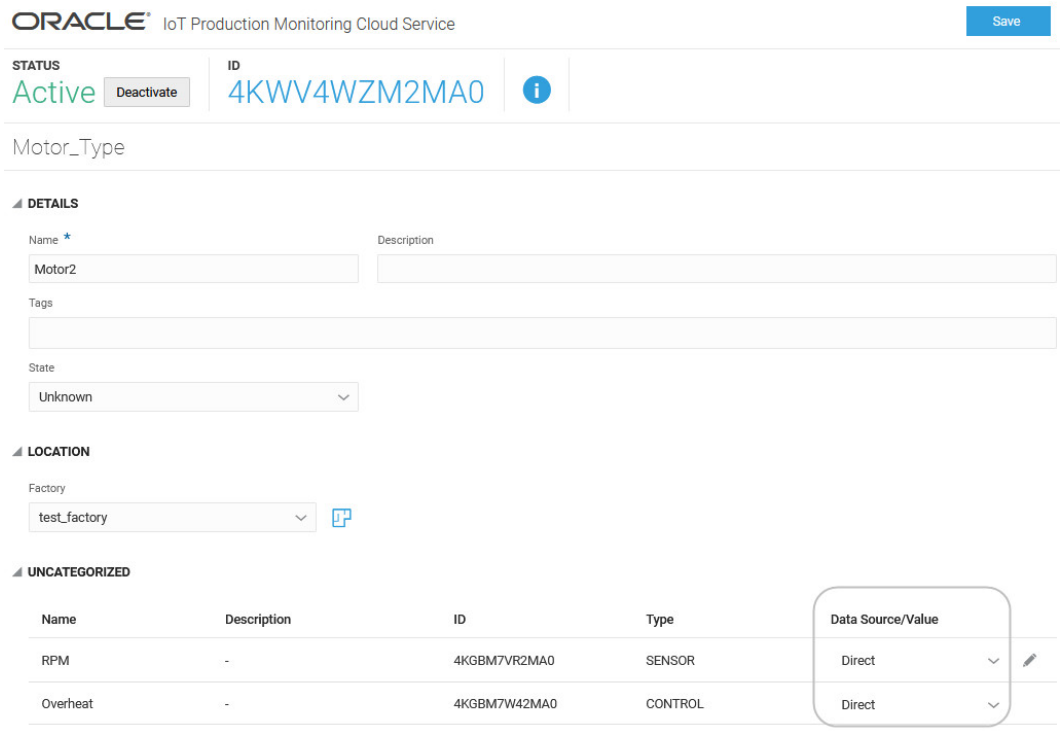
Set Direct Data Options for Your Entity

Use the Create Asset/Machine or Edit Asset/Machine page to set direct data options for the sensor attributes of an entity.

1. On the Create Asset/Machine or Edit Asset/Machine page, set the **Data Source** for one or more sensor attributes to **Direct**.

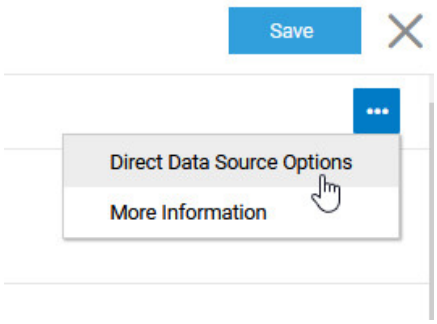


The preceding image shows an asset editor page with two sensor attributes, `Temp` and `Humidity`. The data source for the sensor attributes is set to **Direct**.



The preceding image shows a machine editor page with a sensor attribute, `RPM` and a control attribute, `Overheat`. The data source for the attributes is set to **Direct**.

2. Select **Direct Data Source Options** from the page menu.



3. Select the **Data Source**:
   - **Direct:** Use for devices that can directly connect with the application.
     - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.
     - **Authentication:** Select between **Client Certificate** and **Client ID/Secret**.

Client certificate is the recommended option for increased security. The default **Common Name** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the common name.

If using **Client ID/Secret**, specify a secure password in the **Secret** field. The default **Client ID** used for client certificate is the entity ID. If you have specified an External ID, then this is used as the client ID.

  - **Payload:** Select **Schema** if you are using the standard schema format for data ingestion. Select **Custom** if the payload does not follow the schema. If choosing the custom option, you must specify a previously created **Interpreter** to interpret the payload.

- **Direct via Any Connector:** Use for devices that connect using a connector.

  External ID: You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

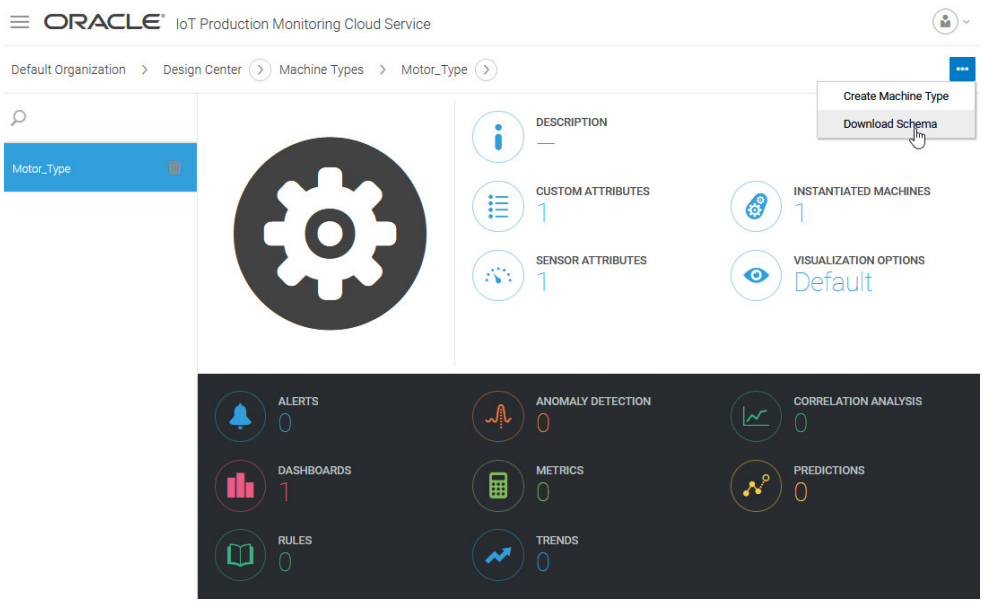
- **Direct via Specific Connector:** Use for devices that can connect using the specified connector.
  - **Connector:** Select a connector that you have previously created.
  - **External ID:** You can enter the external identifier for the device. This is usually the Hardware ID. If you do not enter a value, the default entity ID is used for authentication.

4. Click **OK**, and then click **Save** in the Entity editor.

Download Schema for an Entity Type

Download the JSON or CSV schema for an entity type from the Machine Types page.

1. From the **Menu > Design Center > Machine Types** page, select the machine type for which you wish to download the schema.
2. Select **Download Schema** from the Machine Types menu.



3. Select **JSON Schema** or **CSV** format.

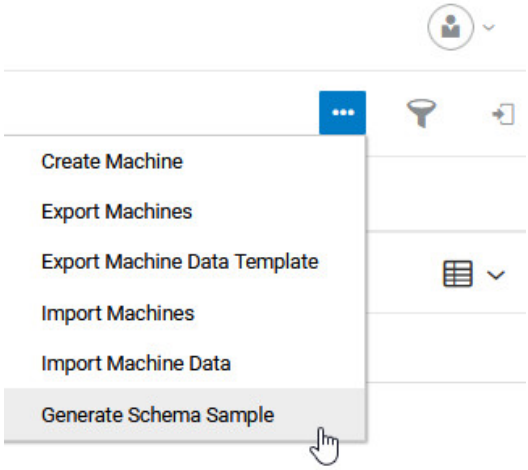
   Choose the schema format that your devices would use to send data for entities of this type.

4. Click **Download** to download the schema file to your hard disk.

Generate Schema Sample for an Entity

Generate the sample schema for an entity to find connection details, such as host, endpoint, topic, and sample payload. You can edit the sample payload values to ingest data.

1. On the Asset Inventory or Machine Inventory page in Design Center, select **Generate Schema Sample** from the Asset/Machine Inventory menu.



2. Select the **Entity Type**.

   The entity type is the asset type or machine type.

3. Choose the payload **Format**.

   The available formats are **JSON** and **CSV**.

4. Select the **Protocol**.

   You can choose between **MQTTS (Publish)** and **HTTP (Post)**. MQTTS will use the topic in addition to the host.

5. Select an **Entity** for which to generate the schema sample.

   The entity is an asset or machine of the selected type.

6. Under **Target Attribute**, select one or all the direct sensor attributes for the entity.

7. Under **Target Entity**, select whether the target entity information is included in the endpoint or the payload itself.

8. Under **Measurement Count**, choose whether the schema sample should include a **Single** reading or **Multiple** readings for the selected attribute.

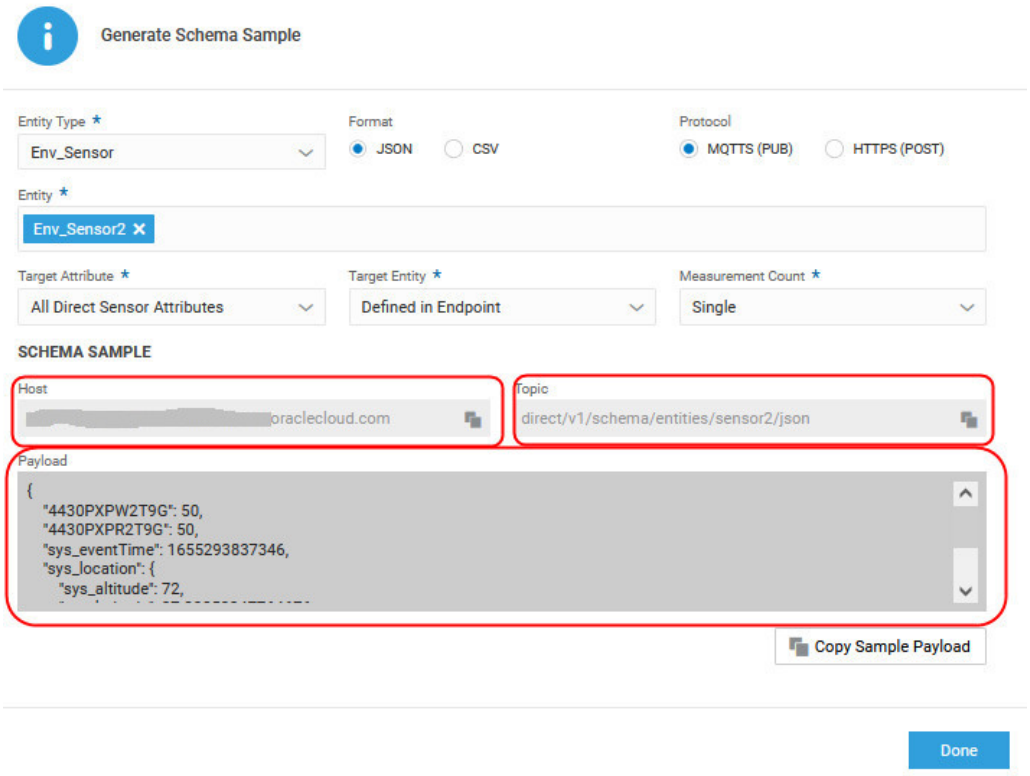
9. Click **Generate** to generate the shcema sample.

   The schema sample is generated along with the endpoint details of the host and topic (for MQTTS). The payload section contains the generated schema for your asset or machine.

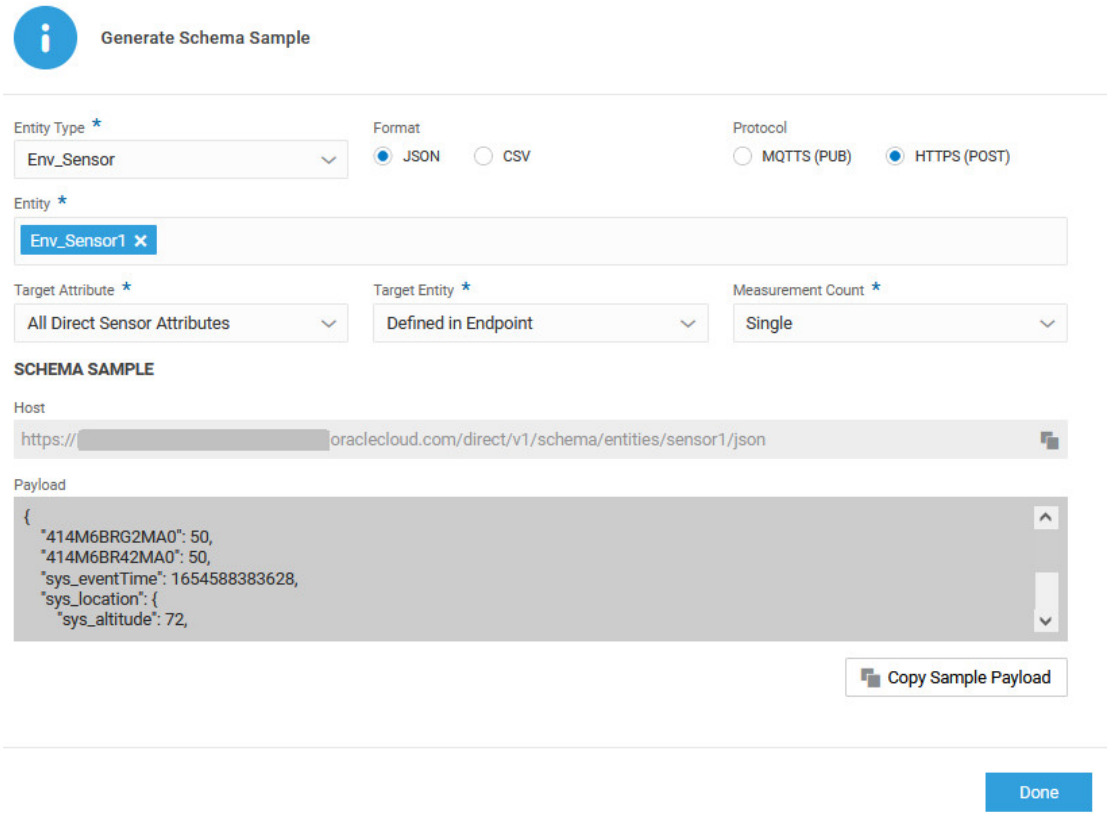
For example, the following JSON payload includes sample data for sensor2, where the target entity information is included in the payload itself.

```
{
    "3J39G39R2MA0": 50,
    "3J39G3A02MA0": 50,
    "sys_eventTime": 1650721170666,
    "sys_entityId": "sensor2",
    "sys_location": {
        "sys_altitude": 72,
        "sys_latitude": 37.39353247764676,
        "sys_longitude": -121.95359884794176
    }
}
```

As shown in the following example for MQTTS, it is convenient to copy details, such as the host, topic, and sample payload from the Generate Schema Sample dialog.



The following example uses the HTTPS protocol:



Create a Connector

Use a connector to directly ingest data from devices, which are not directly connected.

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Organization** from the **Design Center** sub-menu.
3. Click **Device Connections**.
4. Click **Create Connector** to create a new connector.
5. Select between **Gateway** and **Network Server**.

   The **OPC UA** and **Pi System** connectors are also available for Production Monitoring, like in previous releases.
6. Specify a **Name** and optional **Description** for the connector.
7. Enter an **External ID** for the connector. This is usually the Hardware ID.

   The External ID is used as the common name in certificate-based mutual authentication, or as the client ID in password-based authentication.
8. Enter any optional **Tags**.
9. Optionally specify the location coordinates in the **Location** section.
10. Under the **Security** section, specify the **Authentication** method.

    Client certificate is the recommended option for increased security. The External ID that you specified is used as the common name.

If using **Client ID/Secret**, specify a secure password in the **Secret** field. The External ID that you specified is used as the client ID.

11. Under **Authorization**, select the target entities for the connector.

    If you select **Specific Entities**, the connector can send data only for entities bound to the connector.

12. Select the **Payload** type.

    Select **Schema** if you are using the standard schema format for data ingestion. Select **Custom** if the payload does not follow the schema. If choosing the custom option, you must specify a previously created **Interpreter** to interpret the payload.

13. Click **Save** to save the connector.

Create an Interpreter

If you are using a custom payload where the payload does not follow the schema, you can create an interpreter to map the payload for the connector.

1. Click **Menu** (☰), and then click **Design Center**.
2. Select **Organization** from the **Design Center** sub-menu.
3. Click **Device Connections**.
4. Click the **Interpreters** tab and select **Create Interpreter**.
5. Select the interpreter **Type**.

   Mapping interpreters are the most common use case wherein the payload maps to a single entity type. Use **Routing** interpreters for scenarios where the payload maps to multiple entity types.

6. Provide a **Name** and optional **Description** for the interpreter.
7. Select the **Target Entity Type**.

   This is the target asset type or machine type of the entity. Note that this field is not displayed for routing interpreters where the payload can map to multiple entity types.

8. Select the **Target Entity**.

   This is the asset or machine for which you are ingesting and interpreting the data.

9. Select the **Payload Encoding** format.

   The available options are **JSON** and **CSV**.

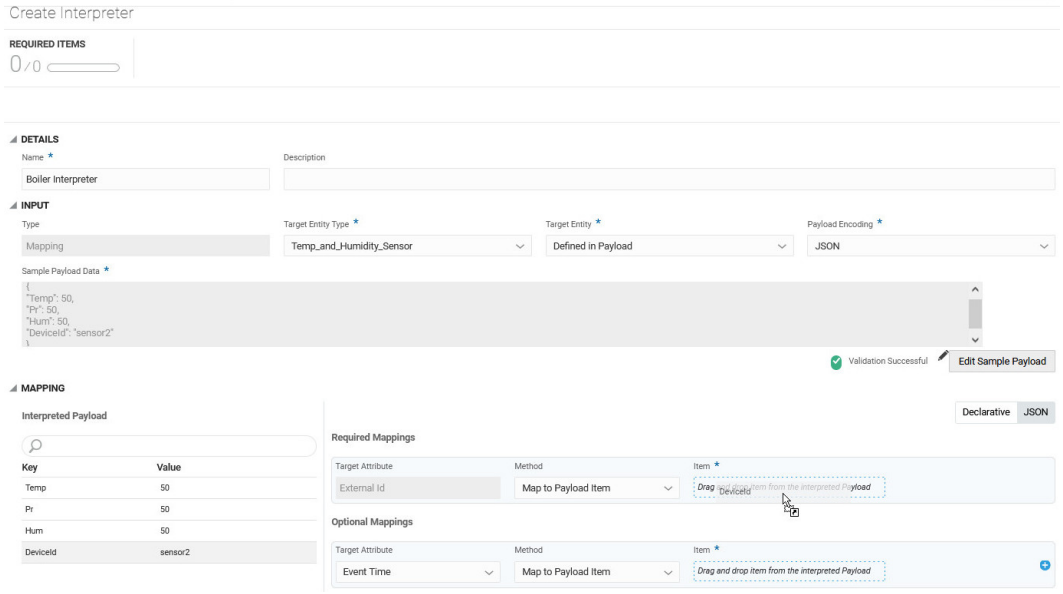
10. Under **Sample Payload Data**, provide the sample JSON or CSV data and click **Validate Data**.

    The sample payload is checked for any syntax/validation errors.

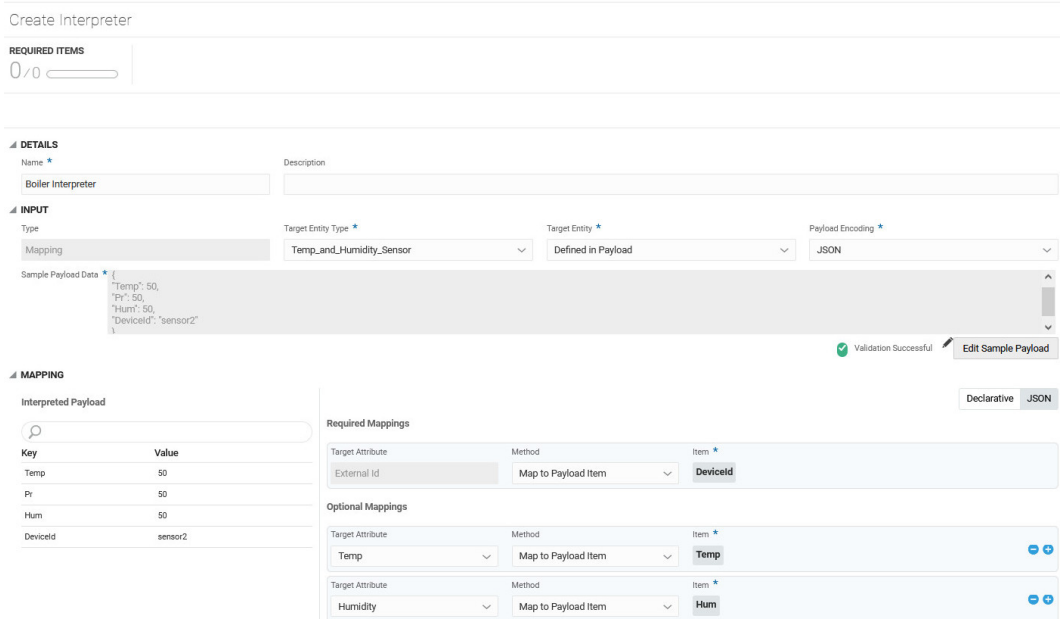
11. In the Mappings section, complete the mappings of the payload to the schema.

    You must complete all required mappings, and any additional mappings that you may have.

    You can drag the payload keys to the appropriate target attributes. The following image shows the `DeviceID` payload key dragged to the `EntityID` attribute.



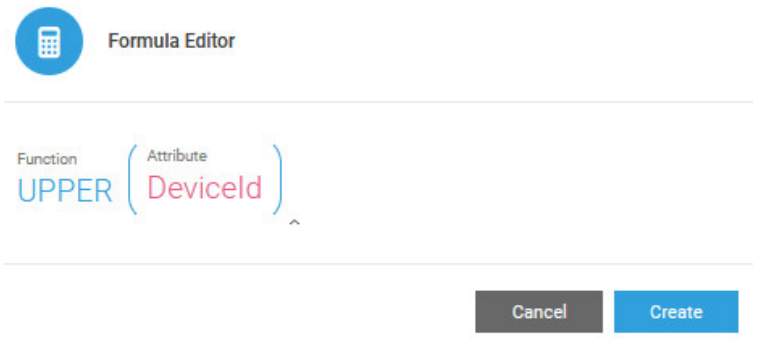
The following image shows a completed mapping.



12. You can also choose **Custom Formula** to complete a mapping.

    Use the formula editor to build and complete your mapping.

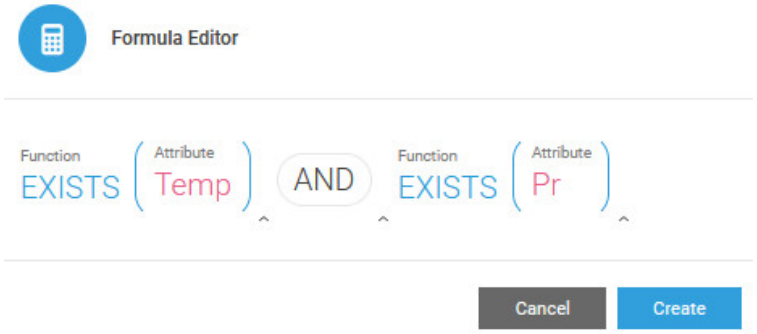
    The following example shows a custom formula for mapping the `DeviceID` to `EntityID`.



13. Define any routing conditions for routing interpreters.

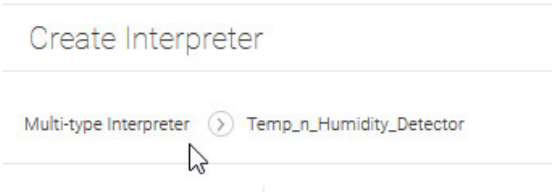
    Use the formula editor to build and complete your condition.

    The following example shows a custom formula for the routing condition.



    a. Select a **Target Entity Type** for the routing condition, and click **Configure Mapping** to complete any required and optional nested mappings for the condition.

       Note that you can navigate back to the main editor using the breadcrumbs that appear at the top of the editor page.



    b. Add more routing conditions, as required.

       The routing will apply to the first applicable routing condition. Once you define more than one condition, you can edit the ordering.

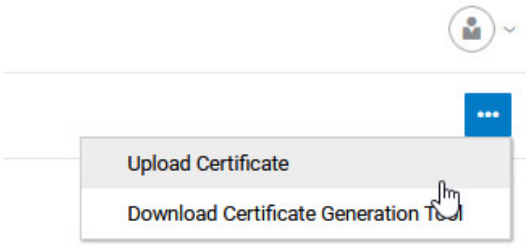
14. Click **Save** to save the interpreter.

Upload and Manage Certificates

As an integrator, you can upload your root certificate, and certificate hierarchy, to your IoT instance. The application can then authenticate your clients devices, gateways, and network servers using the certificate hierarchy. You can also manage your certificates, such as renew or revoke certificates in the application.

The Security area in the Settings section lets you upload and manage certificates. To upload a new certificate:

1. Click **Menu** (☰), and then click **Settings**.
2. Click **Security** on the Settings page.
3. Click **Certificates**.
4. Click **Upload Certificate** to upload a trusted certificate.



5. Specify a **Name**, optional **Description**, and select the `PEM` file to upload.
6. Click **Upload**.
   Oracle recommends that you use a CA certificate. Self-signed certificates are not recommended for production environments.

> **Note:**
>
> You can use the certificate generation tool to generate self-signed certificates. Select **Download Certificate Generation Tool** from the **Certificates** menu to use the same. Use `./gencert.sh help` for usage information on the tool.

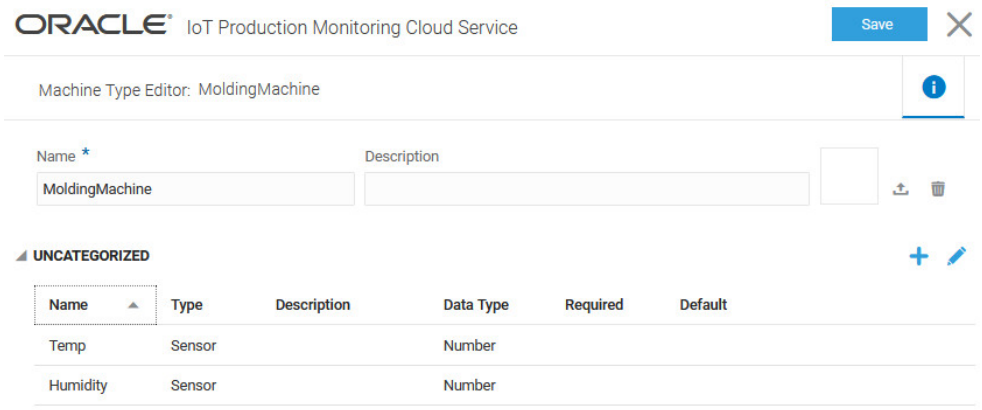
The certificate must be verified before coming into effect. You can choose **Verify Root Certificate** from the Certificates menu to verify the certificate. A verification code is generated, and you need to upload the signed certificate.

You can delegate provisioning to trusted parties by creating intermediate certificates. Create leaf certificates for your devices where the common name is the Entity Id.

Demonstration: Ingest Data for a Directly Connected Device

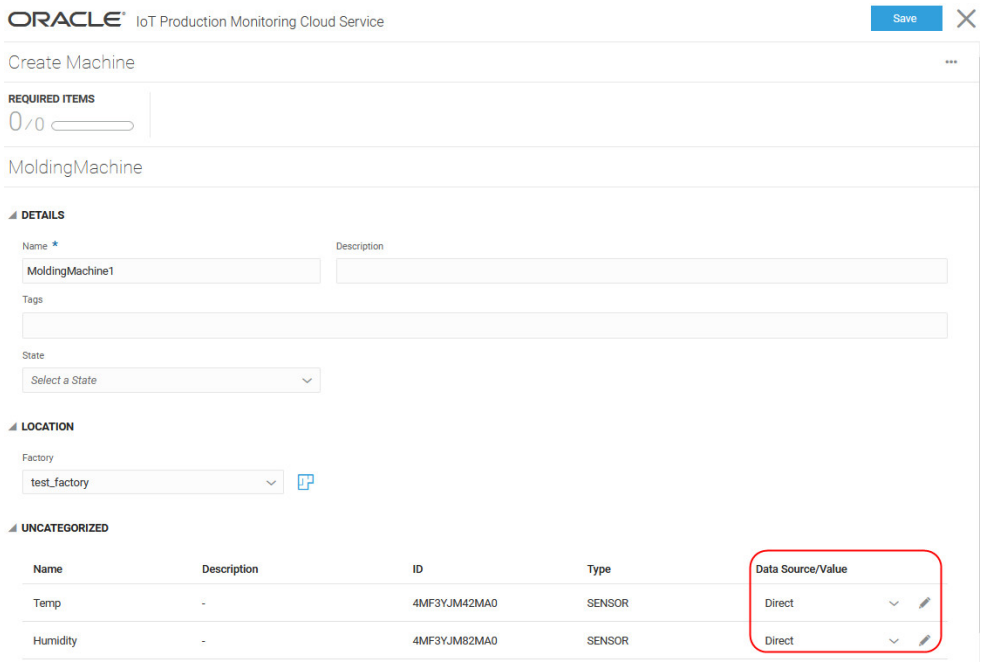
We demonstrate creating a machine and ingesting IoT data for the machine sensor attributes using HTTPS.

1. Create the machine type.



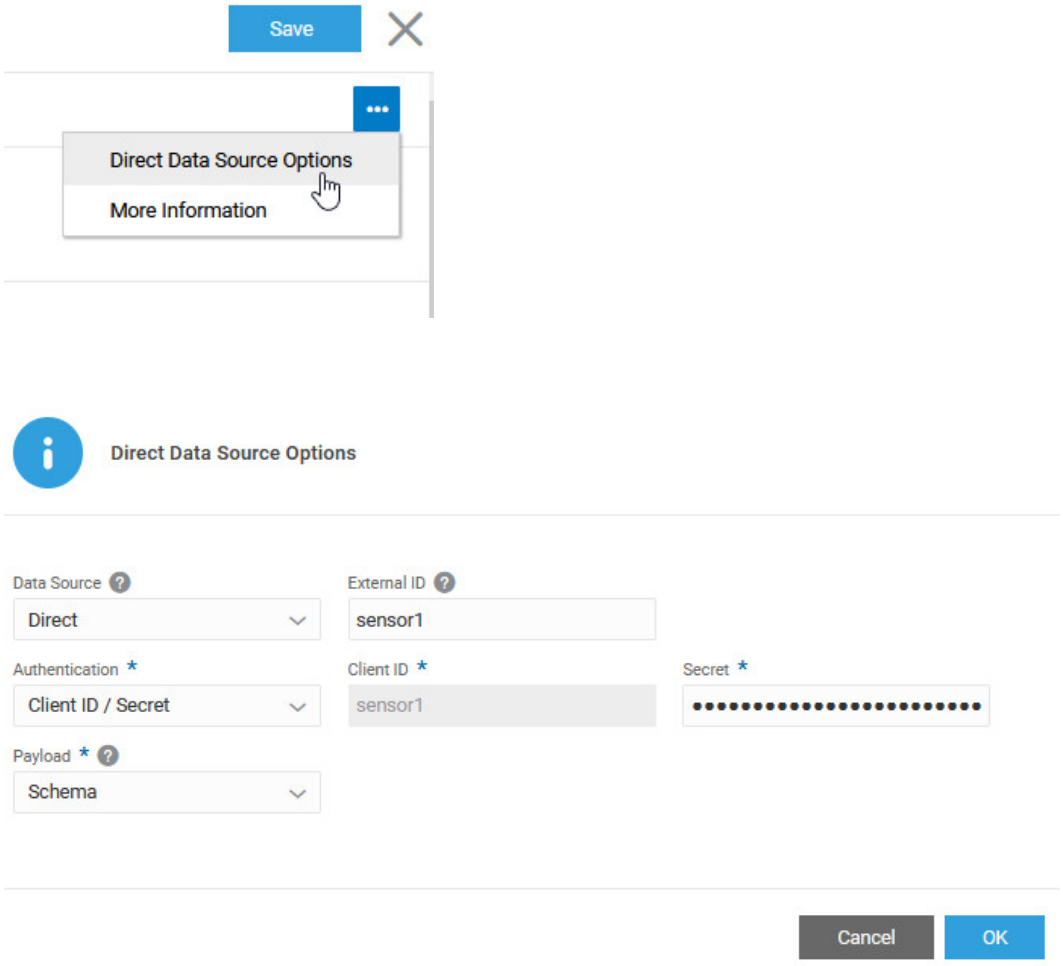
We create a machine type, `MoldingMachine` with sensor attributes for temperature and humidity.

2. Create a machine for the machine type, and set the data source for the sensor attributes to **Direct**.



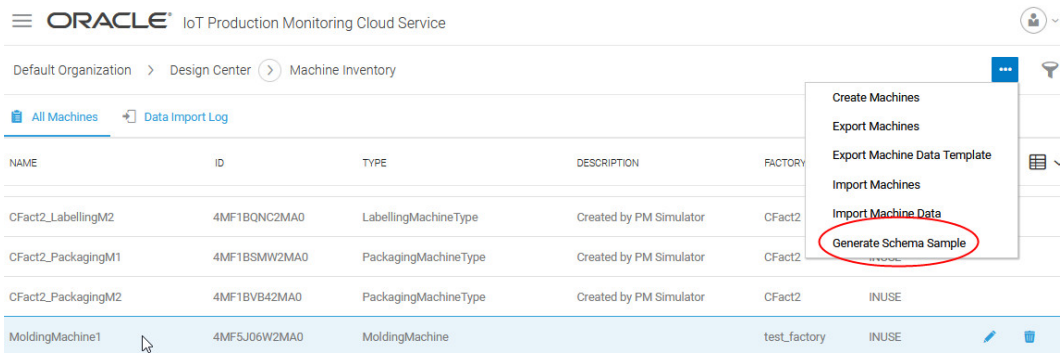
We create a machine, `MoldingMachine1` for the machine type, and set the Data Source value for the sensor attributes `Temp` and `Humidity` to **Direct.**

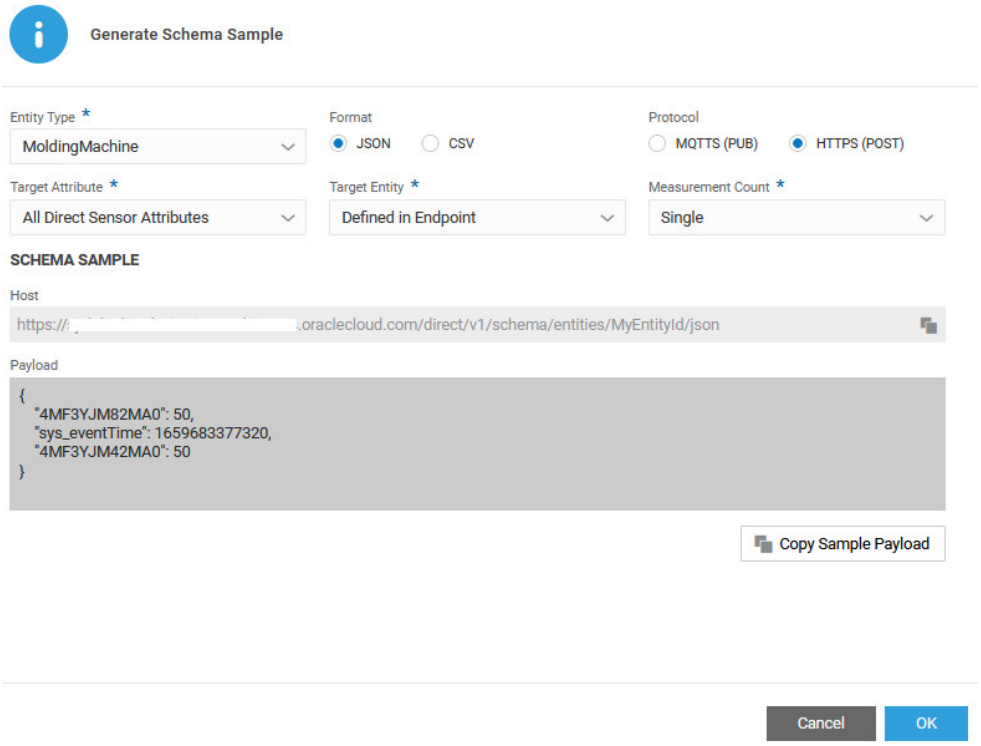
3. Set the **Direct Data Source Options** for the machine in the Machine Editor.



As this is a directly connected device, we choose the **Direct** under **Data Source.** We specify an external ID, `sensor1`. The **External ID** is used as the **Client ID** when the molding machine sends data to the IoT server. We set the authentication method to use **Client ID/Secret** and specify a secure secret password. As we do not need a custom schema, we leave the payload set to the default schema.

4. Generate a sample schema for the machine from the Machine Inventory page.



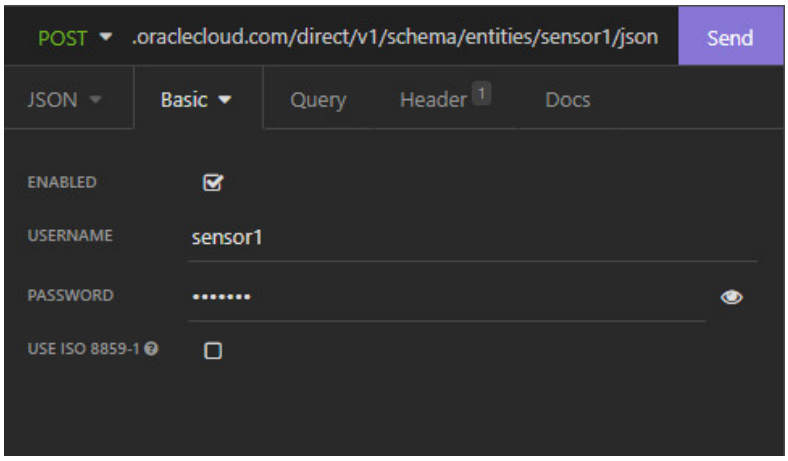


We choose a **JSON** schema and the **HTTPS (POST)** protocol. We choose to generate a sample payload for all the machine sensor attributes. The entity ID is included in the endpoint here, but you could also choose to include it as part of payload. We generate a sample schema for a single measurement.

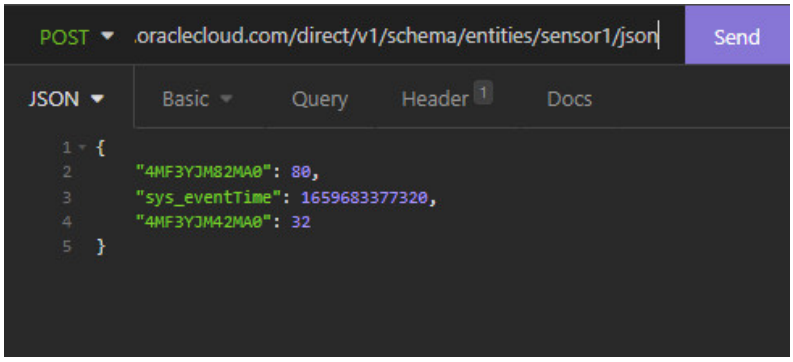
The payload contains sample values for the sensor attributes. Note that the sensor attribute IDs that appear in the payload can be traced to their respective sensor names in the machine editor.

When sending data, say using a REST client or curl command, copy the host, endpoint, and payload from the Sample Schema dialog. Replace `MyEntityID` in the host URL with the external ID for the machine (`sensor1`). Use the external ID/ client ID as the user name and the secret, set earlier, to authenticate. Edit the payload, as required.

5. Send data using a REST client.



We use the host copied from the sample schema dialog for the POST request. We replace `MyEntityID` in the host URL with the external ID for the machine: `sensor1`.We use the client ID and secret values specified in the Direct Data Source Options dialog, as the user name and password in the REST client.



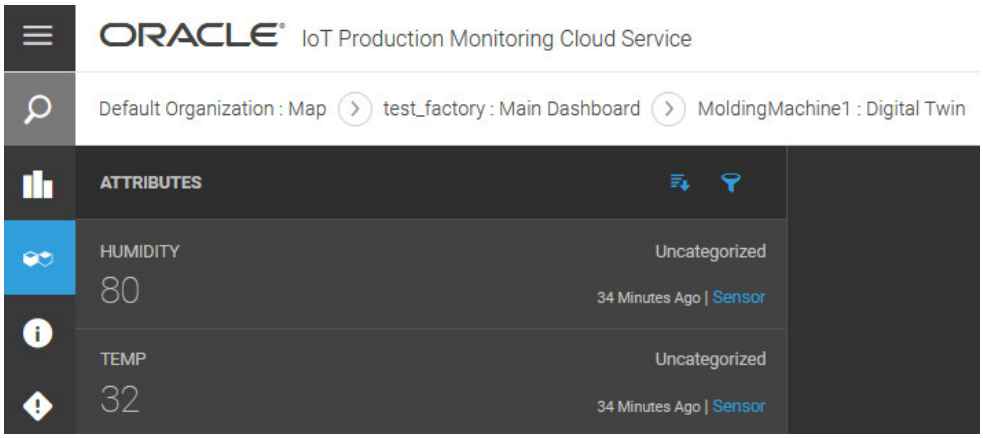
We copy and edit the sample payload from the Direct Data Source Options dialog, and use it as the data for the POST request.

The following shows a sample curl command for the POST request:

```
curl --request POST \
  --url https://iothost.oraclecloud.com/direct/v1/schema/entities/sensor1/
json \
  --header 'Authorization: Basic c2Vuc29yMTpTZW5zb3IxMjM=' \
  --header 'Content-Type: application/json' \
  --data '{
    "4MF3YJM82MA0": 80,
    "sys_eventTime": 1659683377320,
    "4MF3YJM42MA0": 32
}'
```

You may choose to use the curl command directly in place of a REST client.

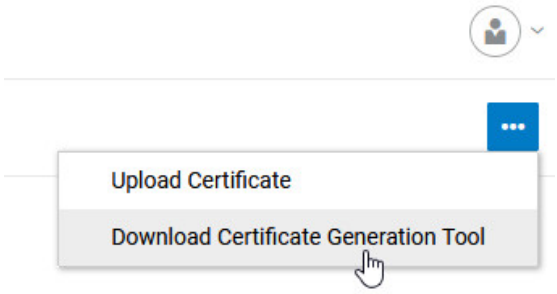
6. Verify that the sent data appears in Operations Center.



Demonstration: Create, Upload, and Verify a Root Certificate

We download and use the **gencert.sh** utility to generate a self-signed root certificate. We next upload the root certificate to the IoT server, and verify it.

1. In your IoT application, navigate to **Menu** ☰ > **Settings** > **Security** > **Certificates**.
2. Select **Download Certificate Generation Tool** from the menu on the Certificates page.



Save the `gencert.sh` script file on your hard disk.

3. Run the **gencert.sh** utility to generate the root certificate.

   You can use the help option to look at the various options: `gencert.sh help`.

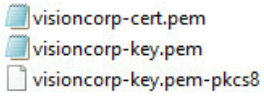
```
bash-4.2$ ./gencert.sh help

./gencert.sh Usage:
        [ help ] prints usage
        [ version ] prints usage
        [ clean ] cleans directory after confirmation
        [ pass <passphrase> ] sets specified passphrase for any future cert that will be generated by this tool
        [ expiry <default-expiration> ] Sets default expiration for all the certs that will be generated by this tool
        [ subject ] Prompt new subject information
        [ root <root-common-name>] generates root prompting for cert details
                Options:
                -x | --expiry <expiry> - set expiration
        [ root <root-common-name> -f <public.pem> <private.pem> ] seeds existing root cert
        [ intermediate <intermediate-common-name> [<parent-common-name>] ] generates another intermediate certificate with given common name issued by sp
ecified parent.
                        Default parent is root.
                Options:
                -x | --expiry <expiry> - set expiration
                -p | --parent <parent-common-name> - parent common name. Parent should be root or intermediate
                -i | --issuer <certificate-path> <private-key-path> - Use external certificate to create intermediate.
                -l | --pathlen <pathlen> - set custom pathlen.
                        The pathlen parameter indicates the maximum number of intermediate certificates that can appear below this one in a chain
        [ leaf <leaf-common-name> ] generates leaf certificate with given common-name issued by intermediate common-name (default is last used)
                Options:
                -x | --expiry <expiry> - set expiration
                -p | --parent <parent-common-name> - parent common name. Parent should be root or intermediate
                -i | --issuer <certificate-path> <private-key-path> - Use external certificate to create leaf.
        [ verify <cert-common-name> <verification-code> ] generates verification certificate for the given cert (CN) and the verification code
        [ verify <certificate-file> <private-key-file> <verification-code> ] generates verification certificate for the certificate and the verification
code
        [ crl <CRL-distribution-URL> ] sets Certificate Revocation List distribution URL for all certs that will be generated by this tool.
              CRL-distribution-URL is base URL where all the CRL files are located.
        [ revoke <common-name> ] revokes the cert specified by given common-name
        [ certificate <common-name> ] show certificate
```

We use **visioncorp** as the root common name for our root certificate.

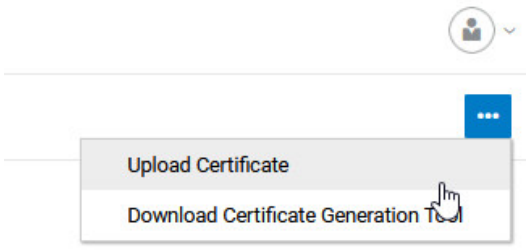
Issue the following command: `gencert.sh root visioncorp`. We use the default options for other parameters, such as *Country* and *State*. Press Enter when the command prompts for these options, so as to accept the default option.

```
bash-4.2$ ./gencert.sh root visioncorp
Type certificate information
Country[US]:
State[CA]:
Location[San Francisco]:
Organization[Org]:
Unit[San Francisco]:
email[hello@example.com]:
Generating RSA private key, 4096 bit long modulus
..........++
.............................................................++
e is 65537 (0x10001)
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            86:0c:b5:a6:08:62:5e:0c
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: CN=visioncorp, C=US, ST=CA, L=San Francisco, O=Org, OU=San Francisco/emailAddress=hello@example.com
        Validity
            Not Before: Jun 10 08:42:30 2022 GMT
            Not After : Jun  5 08:42:30 2042 GMT
        Subject: CN=visioncorp, C=US, ST=CA, L=San Francisco, O=Org, OU=San Francisco/emailAddress=hello@example.com
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (4096 bit)
```

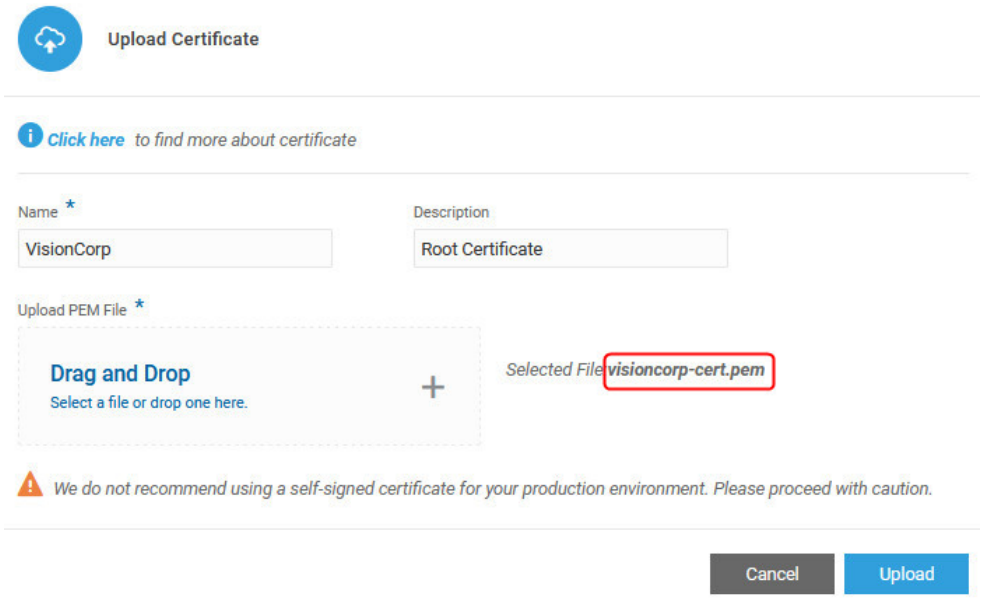
The tool generates files, such as the root certificate file (`visioncorp-cert.pem`) and the private key (`visioncorp-key.pem`) in the `certs\visioncorp` directory.



4. On the Certificates page, use the **Upload Certificate** menu option to upload the root certificate.

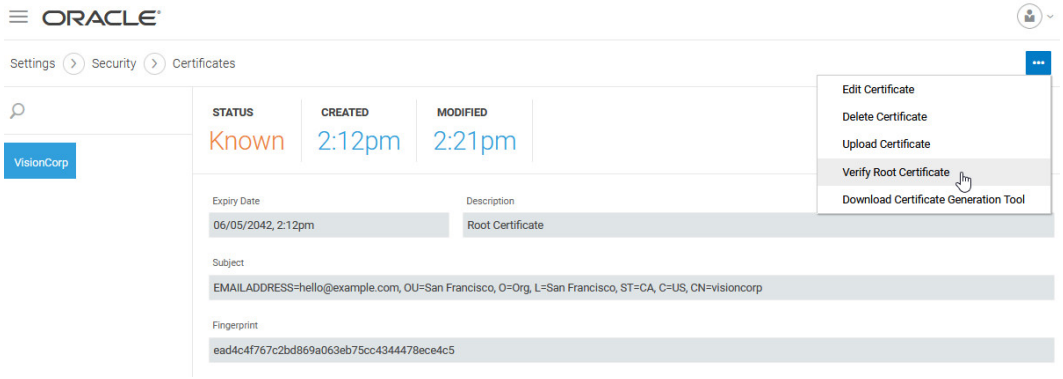


We provide a root certificate name and description, and upload the `visioncorp-cert.pem` file.

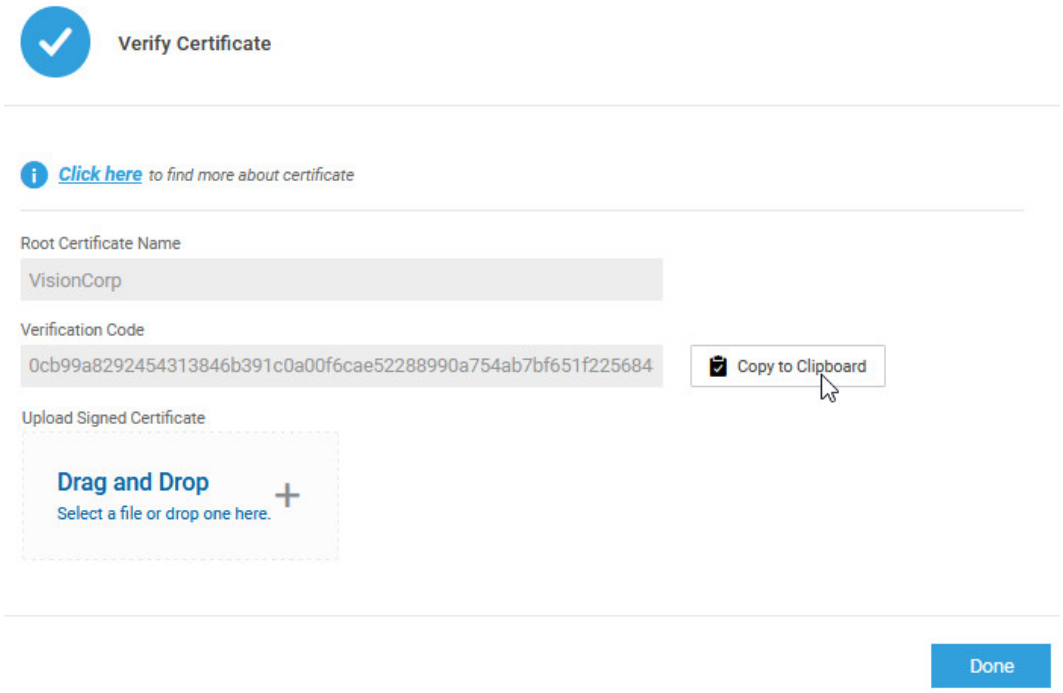


> **Note:**
>
> In your production environment, you would normally use a certificate issued by your CA, as opposed to a self-signed certificate.

5. Use the **Verify Root Certificate** option to verify the root certificate.



The server generates a verification code challenge that we need to sign with the private key to verify the certificate. Click **Copy to Clipboard** to copy the verification code. We'd next use it in the `gencert.sh` utility to generate the verification certificate.



6. Use the `gencert.sh` command to generate the verification certificate by signing the verification code with the private key associated with the root certificate.

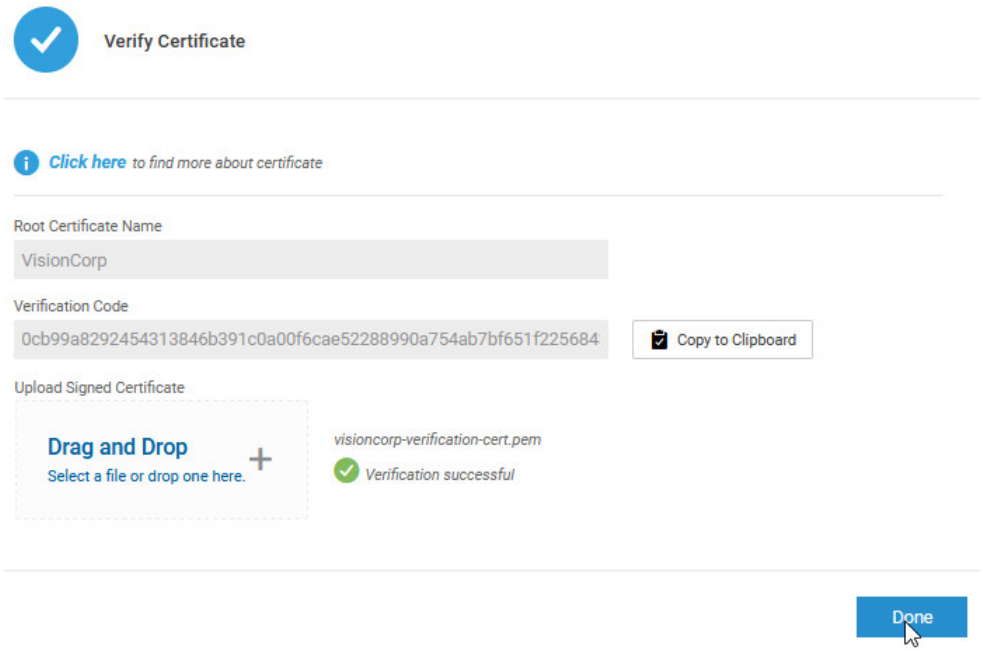
   `gencert.sh verify` *`cert-common-name verification-code`* generates the verification certificate for the given certificate common name (CN) and verification code.

   We use the copied verification code in the following command:

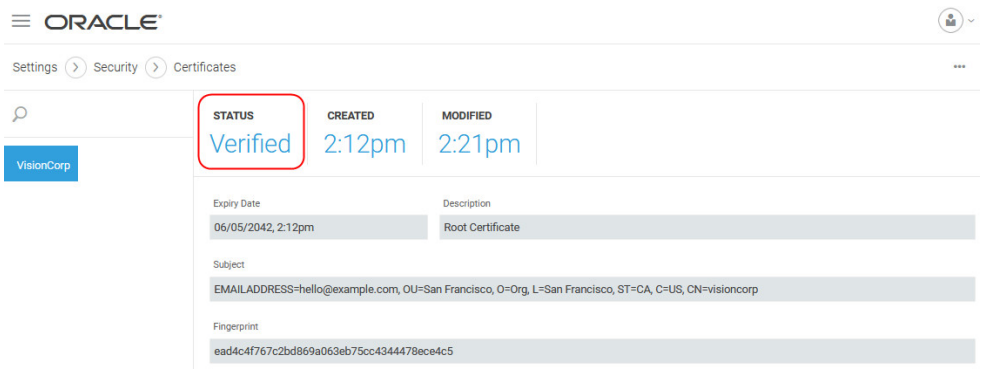
```
bash-4.2$ ./gencert.sh verify visioncorp 0cb99a8292454313846b391c0a00f6cae52288990a754ab7bf651f2256843aa4
Signature ok
subject=/CN=0cb99a8292454313846b391c0a00f6cae52288990a754ab7bf651f2256843aa4
Getting CA Private Key
```

The `gencert.sh` tool adds the `visioncorp-verification-cert.pem` file to the `certs\visioncorp` directory.

7. Upload the signed certificate (`visioncorp-verification-cert.pem`) in the **Verify Certificate** dialog and confirm successful verification.



Notice that the status of the root certificate changes from *Known* to *Verified*.

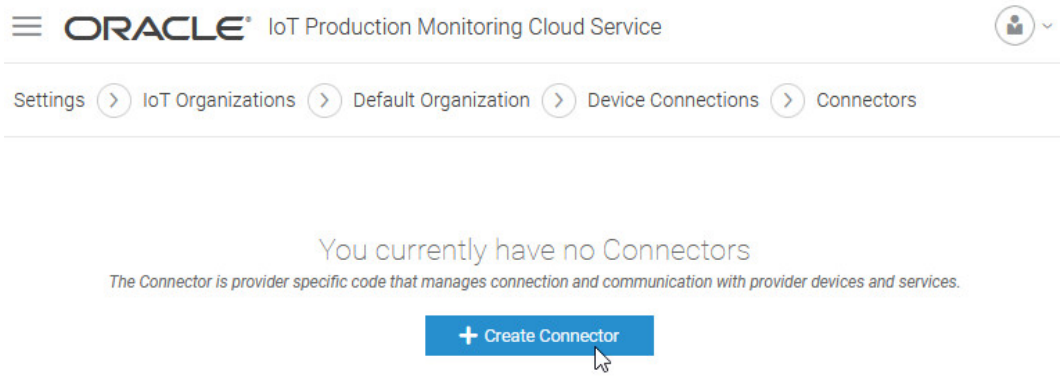


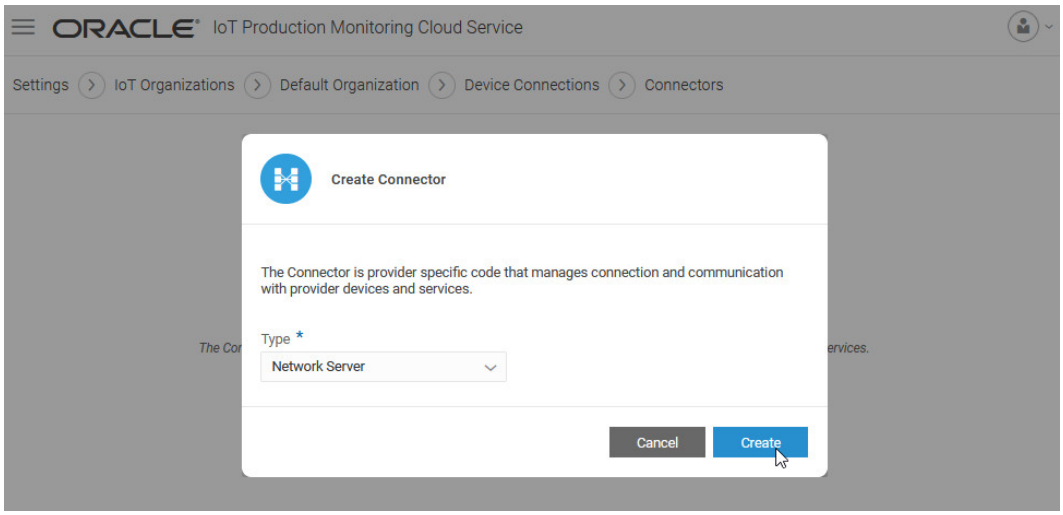
Demonstration: Ingest Data Through a Connector Using Certificate-Based Authentication

We create a connecter, and ingest data for a machine that connects through this connector. We create and use the leaf certificate of the connector to authenticate with the IoT server. We use the MQTTS protocol to publish data.

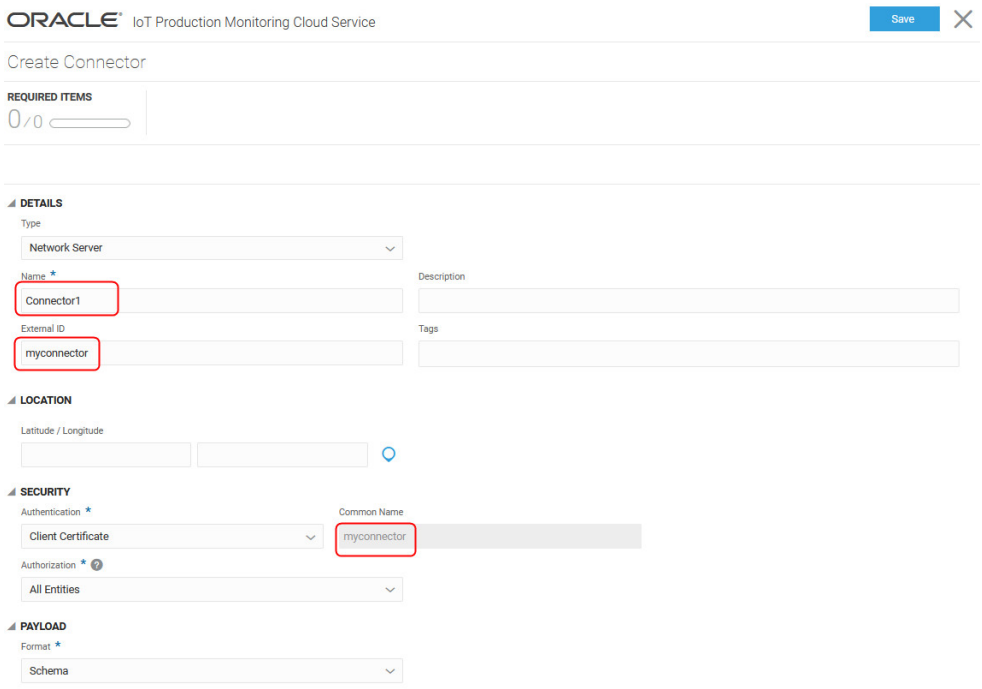
The IoT server traces the certificate chain to the validated root certificate and allows data ingestion for the machine.

1. Use the **Create Connector** option to create a connector from the **Menu >Settings > IoT Organizations > *Organization Name* > Device Connections > Connectors** page.



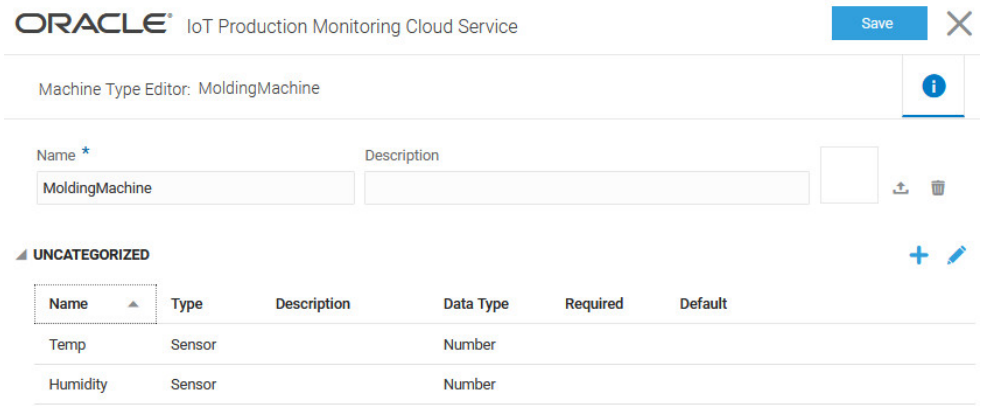


We create a **Network Server** connector here. You could also create a gateway connector.



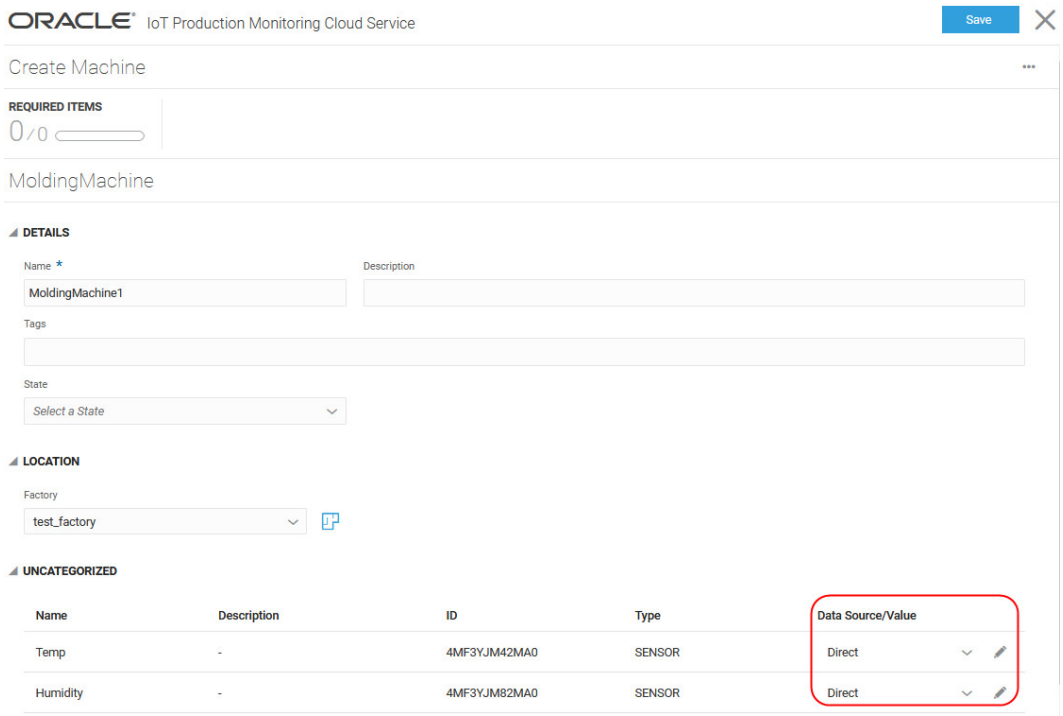
We specify a connector **Name** (`Connector1`) and **External ID** (`myconnector`). We choose **Client Certificate** authentication. The **External ID** of the connector is used as the **Common Name** for client certificate authentication. When creating a leaf certificate for the connector, we must use the same common name.

2. Create the machine type.



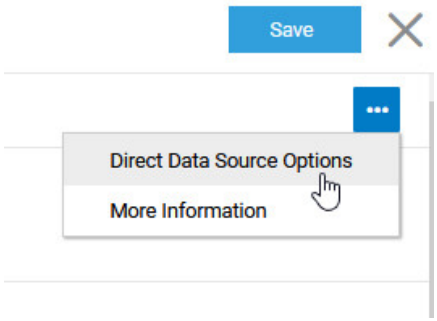
We create a machine type, `MoldingMachine` with sensor attributes for temperature and humidity.

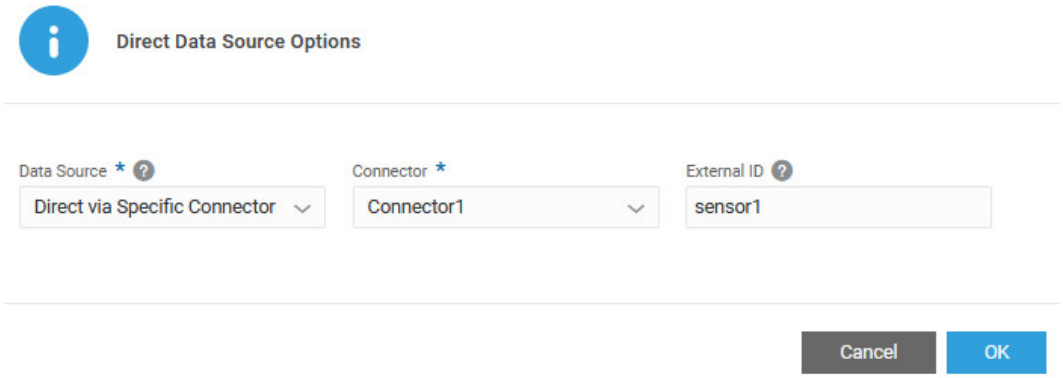
3. Create a machine for the machine type, and set the data source for the sensor attributes to **Direct**.



We create a machine, `MoldingMachine1` for the machine type, and set the Data Source value for the sensor attributes `Temp` and `Humidity` to **Direct.**

4. Set the **Direct Data Source Options** for the machine in the Machine Editor.





We configure the machine sensor attributes to use the connector that we created. We specify an external ID, `sensor1` to identify the sensor device in the MQTT topic.

5. Create the certificate hierarchy in IoT and create the leaf certificate for the connector.

   We create an intermediate certificate for the verified root certificate and upload it to the IoT server. Next, we create a leaf certificate with the intermediate certificate as its parent. The leaf certificate uses the common name of the connector. The leaf certificate is used by the connector when connecting to the IoT server to send data for the machine.

   a. Create an intermediate certificate for the verified root certificate.

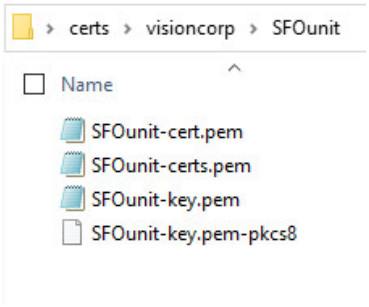
      We run the `gencert.sh` utility to generate the intermediate certificate:

      `./gencert.sh intermediate` *`intermediate-common-name`* `--parent` *`parent-common-name`*

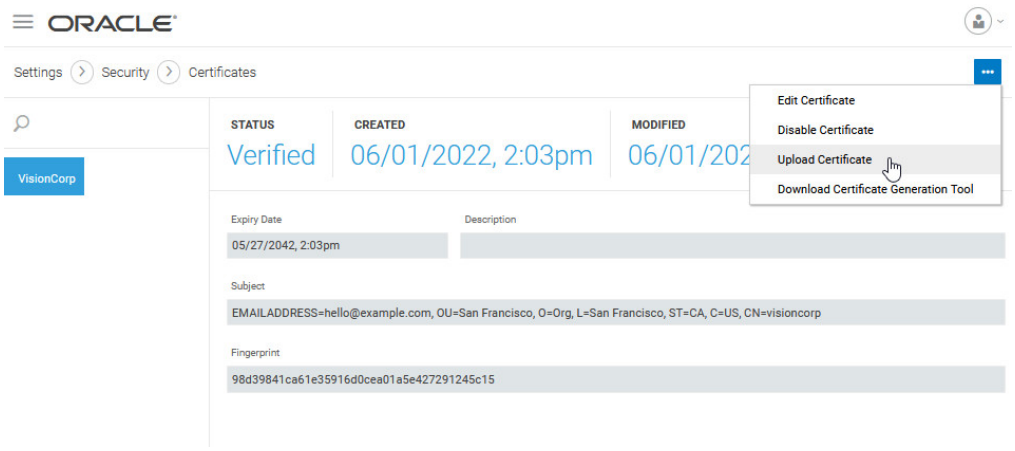
```
bash-4.2$ ./gencert.sh intermediate SFOunit --parent visioncorp
Type certificate information
Country[US]:
State[CA]:
Location[San Francisco]:
Organization[Org]:
Unit[San Francisco]:
email[hello@example.com]:
Generating RSA private key, 4096 bit long modulus
.....................................................................................................++
.....................................................++
e is 65537 (0x10001)
Using configuration from data/config/inter_open_ssl.cnf
Check that the request matches the signature
Signature ok
Certificate Details:
        Serial Number:
            d0:34:6b:ca:3f:69:86:41
        Validity
            Not Before: Jun 15 06:33:28 2022 GMT
            Not After : Jun 10 06:33:28 2042 GMT
        Subject:
            countryName               = US
            stateOrProvinceName       = CA
            localityName              = San Francisco
            organizationName          = Org
            organizationalUnitName    = San Francisco
            commonName                = SFOunit
            emailAddress              = hello@example.com
        X509v3 extensions:
            X509v3 Subject Key Identifier:
                AC:31:C0:E1:AF:33:72:DA:A3:98:AD:D4:19:AB:52:CB:31:3B:F8:D9
            X509v3 Authority Key Identifier:
                keyid:0E:C8:54:53:09:B6:FF:6D:74:6A:29:74:7E:5E:60:AF:48:B6:54:5B
```

      We use the common name `SFOunit` for the intermediate certificate and create it under the verified `visioncorp` root certificate. We use the default options for other parameters, such as *Country* and *State*. Press Enter when the command prompts for these options, so as to accept the default option.

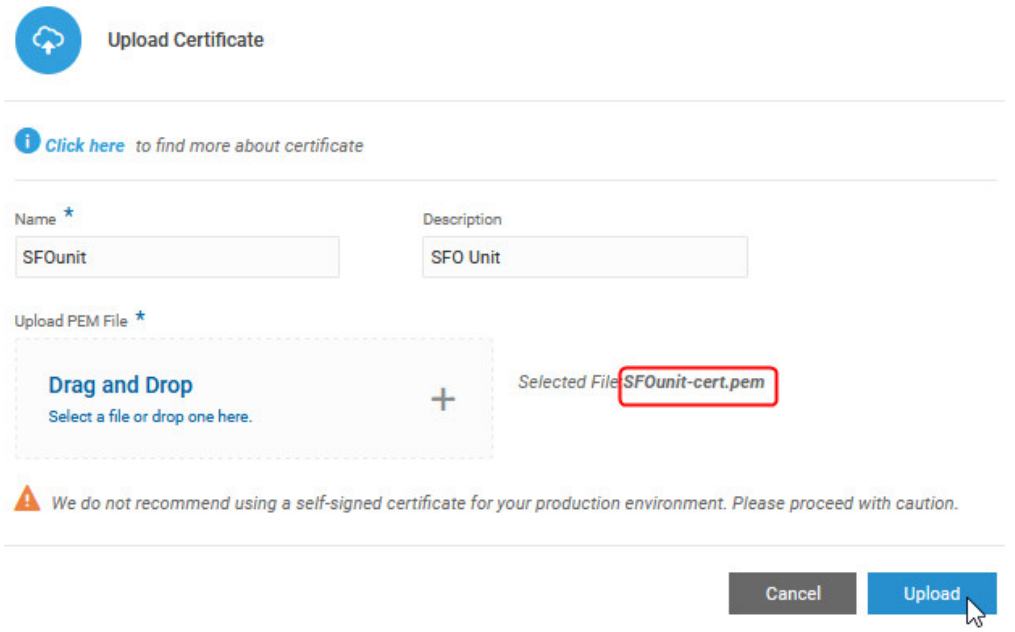
      The tool generates files, such as the intermediate certificate file (`SFOunit-cert.pem`) and the private key (`SFOunit-key.pem`) under the `certs\visioncorp\SFOunit` directory.



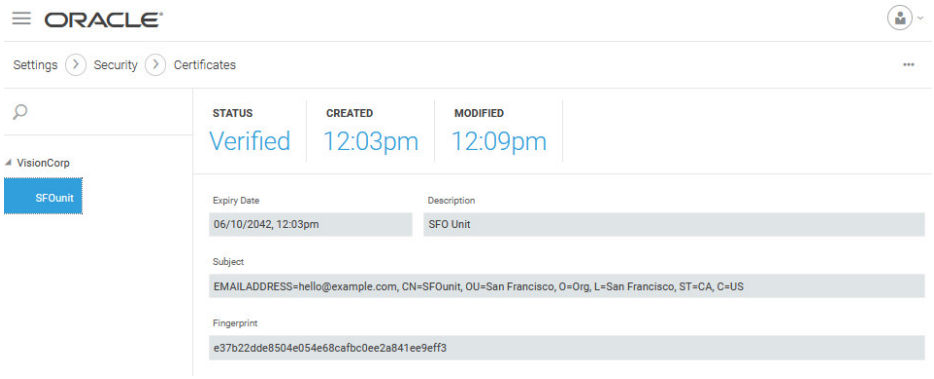
b. Upload the intermediate certificate to the IoT server.



We upload the certificate from the **Settings > Security > Certificates** page.



We specify a name and description for the certificate and upload the `SFOunit-cert.pem` certificate file.



The uploaded intermediate certificate appears on the Certificates page under the root certificate. Note that the SFOunit certificate is already verified, as it was created under the verified root certificate.

c. Create a leaf certificate for the connector.

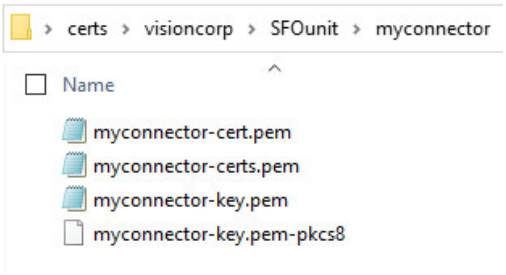
We run the `gencert.sh` utility to generate the leaf certificate:

`./gencert.sh leaf` *`leaf-common-name`* `--parent` *`parent-common-name`*

```
bash-4.2$ ./gencert.sh leaf myconnector --parent SFOunit
Type certificate information
Country[US]:
State[CA]:
Location[San Francisco]:
Organization[Org]:
Unit[San Francisco]:
email[hello@example.com]:
Generating RSA private key, 4096 bit long modulus
.....................................................................................................++
..................
.....................................................................................++
e is 65537 (0x10001)
Using configuration from data/config/inter_open_ssl.cnf
Check that the request matches the signature
Signature ok
Certificate Details:
        Serial Number:
            d0:34:6b:ca:3f:69:86:42
        Validity
            Not Before: Jun 15 09:48:12 2022 GMT
            Not After : Jun 10 09:48:12 2042 GMT
        Subject:
            countryName               = US
            stateOrProvinceName       = CA
            localityName              = San Francisco
```

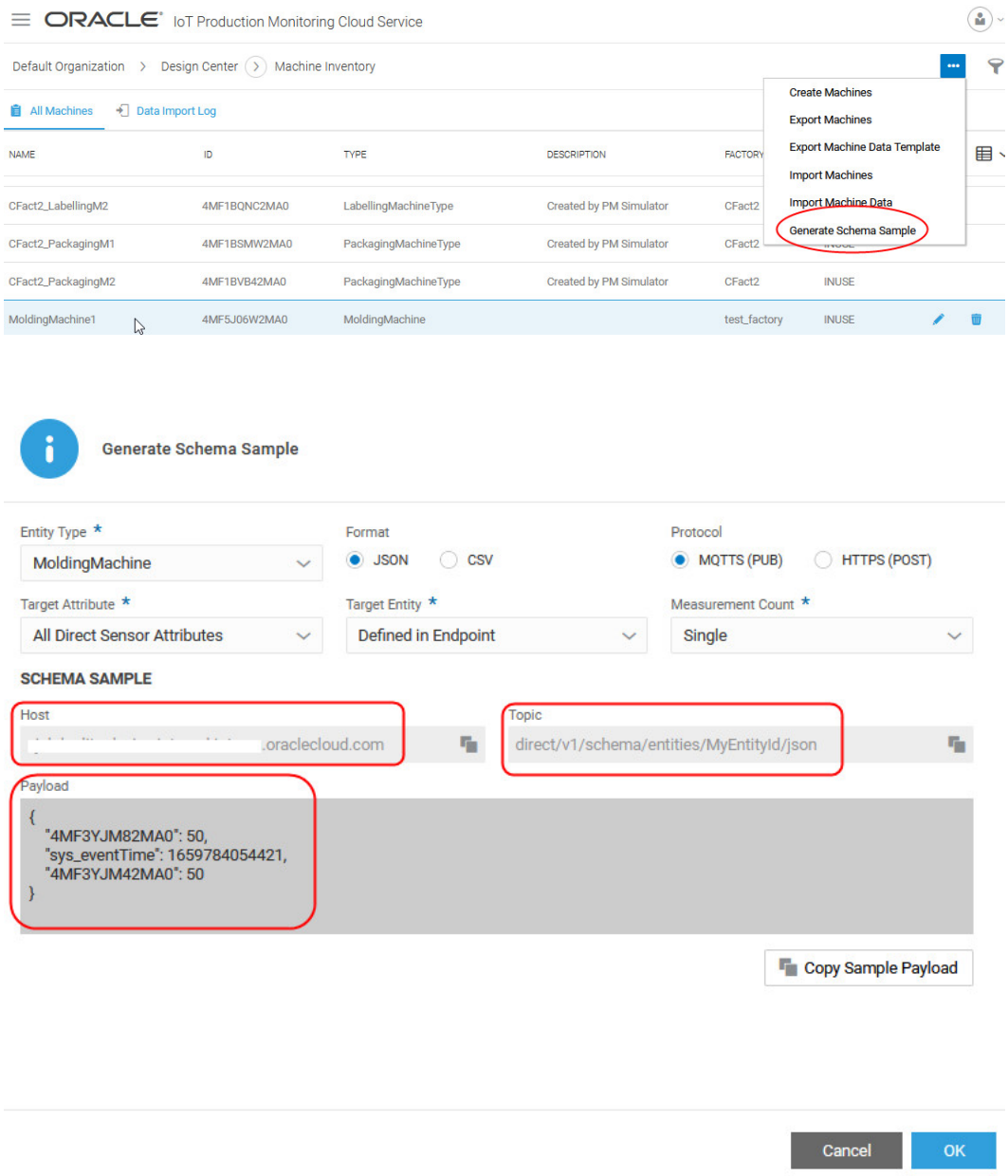
Note that the common name for the connector leaf certificate (`myconnector`) is the same as the external ID that we specified for our connector. The leaf certificate is created with the intermediate certificate as its parent.

The tool generates files, such as the leaf certificate file (`myconnector-cert.pem`) and the private key (`myconnector-key.pem`) under the `certs\visioncorp\SFOunit\myconnector` directory.



We use the leaf certificate of the connector when sending data for the IoT device connected through the connector.

6. Generate a sample schema for the machine from the Machine Inventory page.

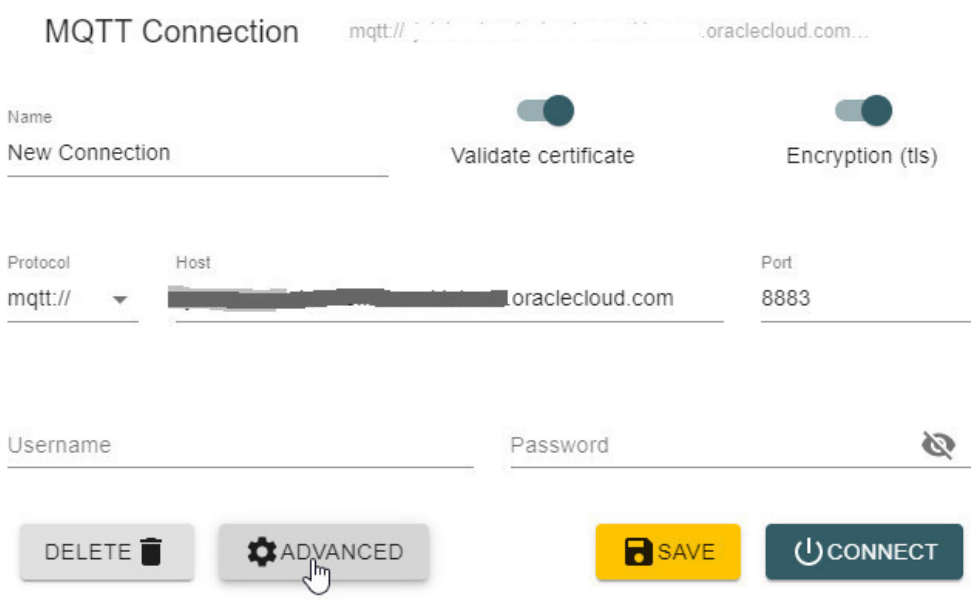


We choose a **JSON** schema and the **MQTTS (PUB)** protocol. We choose to generate a sample payload for all the machine sensor attributes. The entity ID is included in the endpoint here, but you could also choose to include it as part of payload. We generate a sample schema for a single measurement.

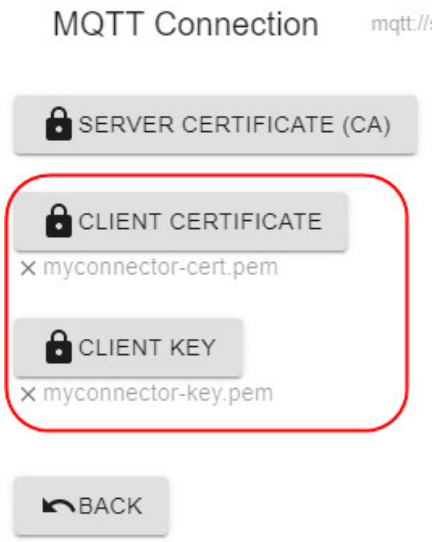
The payload contains sample values for the sensor attributes. Note that the sensor attribute IDs that appear in the payload can be traced to their respective sensor names in the machine editor.

When sending data, say using MQTT Explorer, copy the host, topic, and payload from the Sample Schema dialog. Replace `MyEntityID` in the topic with the external ID for the machine (`sensor1`). Use the connector leaf certificate to authenticate. Edit the payload, as required.

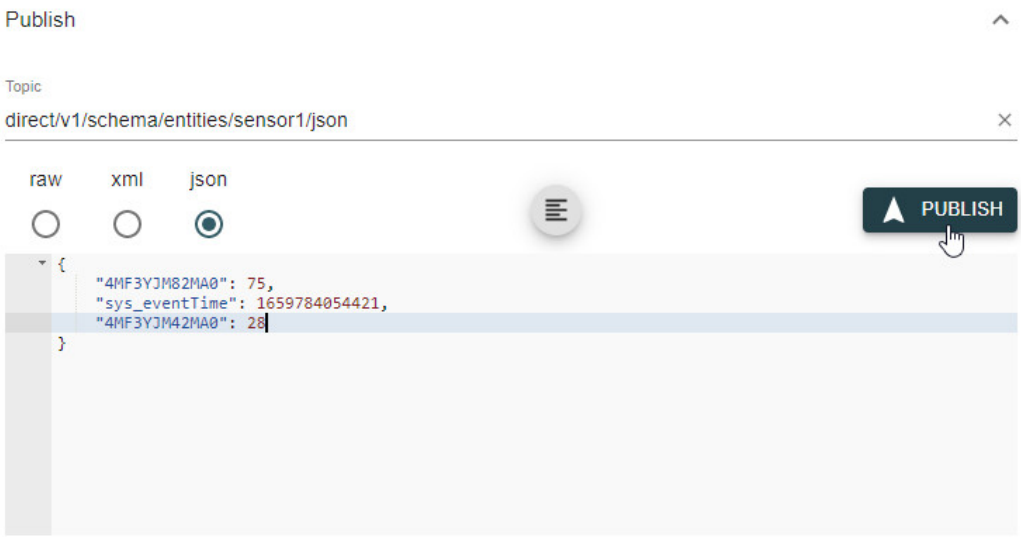
7. Send data for the device connected through the connector using an MQTT client.



We use the host info that we copied from the sample schema dialog. Make sure that the encryption switch is ON, and use the secure port 8883.

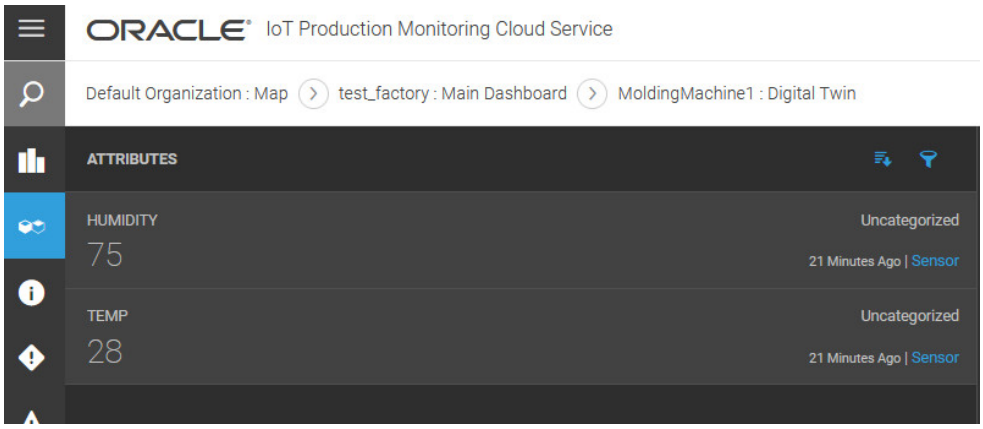


We upload the connector leaf certificate and key under the Advanced section. If you were using a directly connected device, you would use the leaf certificate for the device itself.



Once connected to the IoT server, we use the topic and payload information copied from the Sample Schema dialog. We replace `MyEntityID` in the topic with the external ID for the machine: `sensor1`. We edit the payload values as necessary, and publish.

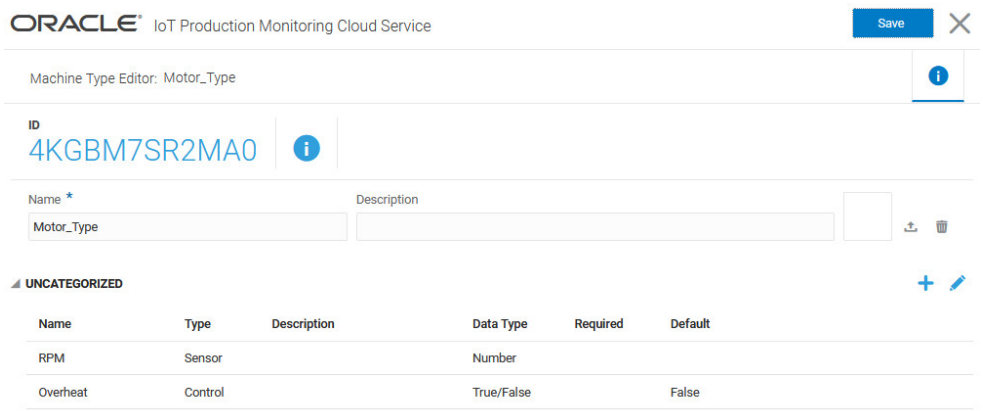
8. Verify that the published data appears in Operations Center.



Demonstration: Send Back Control Data to a Directly Connected Device

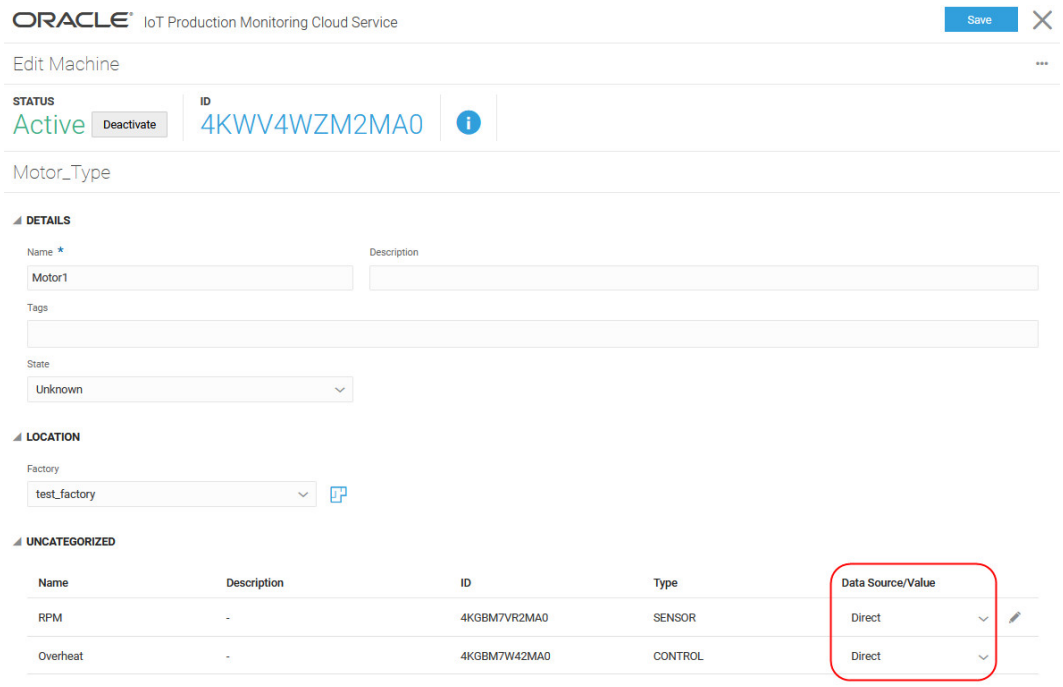
We demonstrate two-way communication with your IoT device using MQTT direct ingestion. Control attributes are used to send back control signals to the IoT device.

1. Create the machine type with sensor and control attributes.



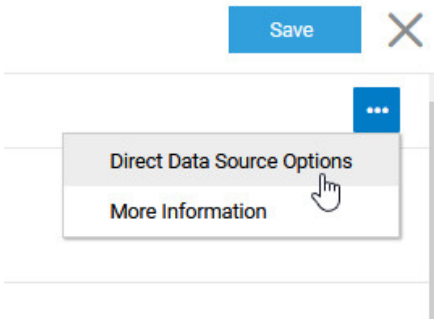
We create a machine type, `Motor_Type` with one sensor attribute and one control attribute. The sensor attribute `RPM` measures the motor RPM. The control attribute `Overheat` is used to send the overheat signal from your IoT application.

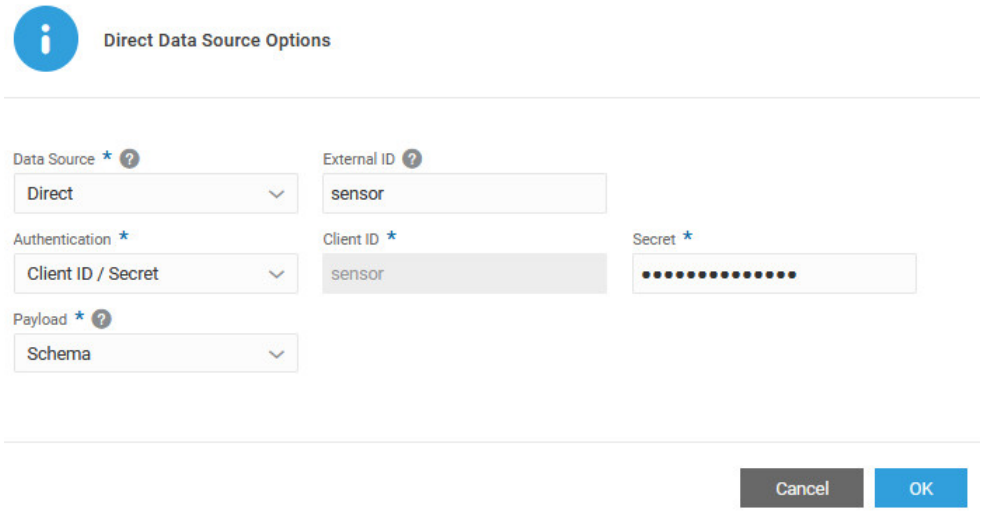
2. Create a machine for the machine type, and set the data source for the sensor and control attributes to **Direct**.



We create a machine, `Motor1` for the machine type, and set the Data Source value for the sensor attribute `RPM` and control attribute `Overheat` to **Direct.**

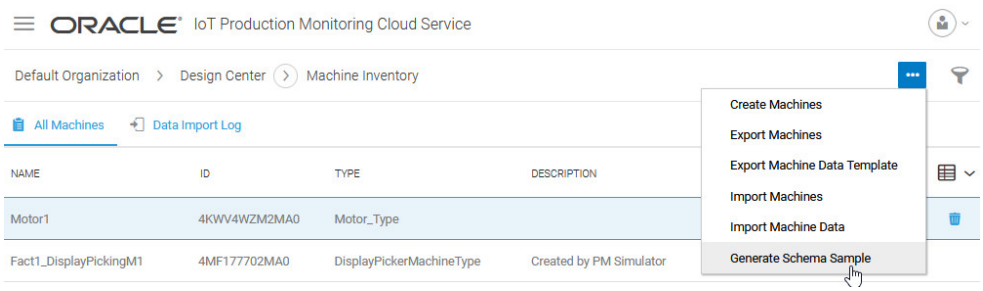
3. Set the **Direct Data Source Options** for the machine from the Machine Editor menu.

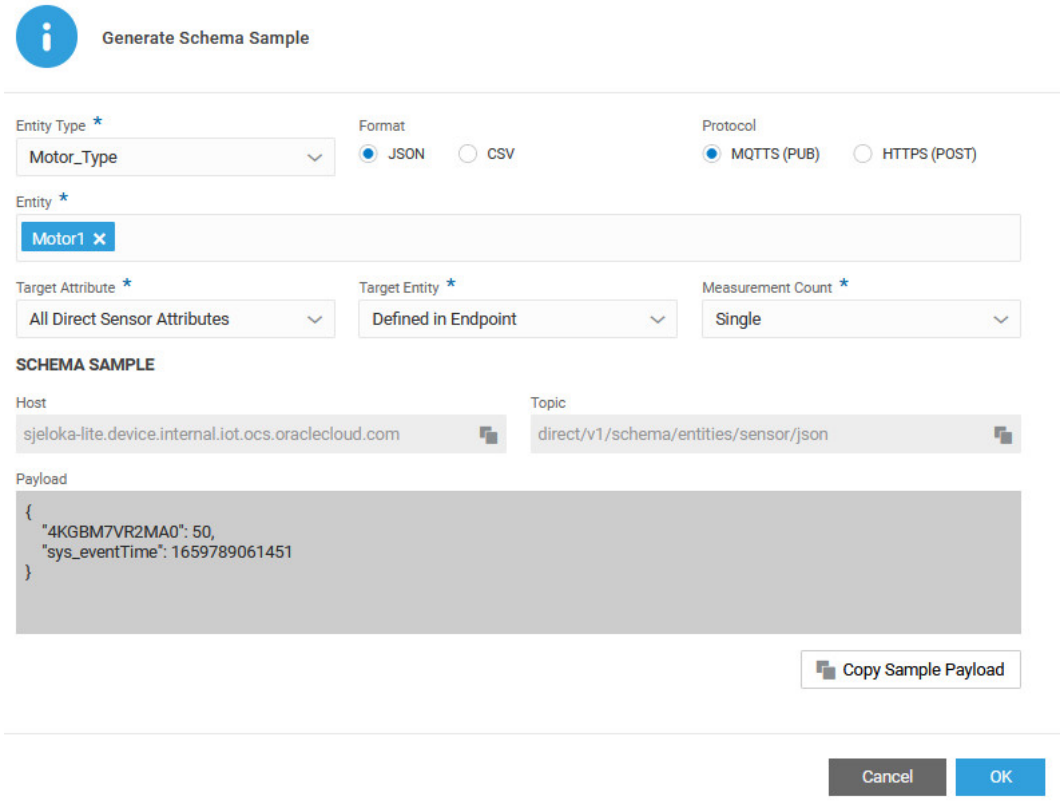




As this is a directly connected device, we choose **Direct** under **Data Source.** We specify an external ID, `sensor`. The **External ID** is used as the **Client ID** when the device sends RPM data to the IoT server. We set the authentication method to use **Client ID/Secret** and specify a secure secret password. As we do not need a custom schema, we leave the payload set to the default schema.

4. Generate a sample schema for the machine from the Machine Inventory page.





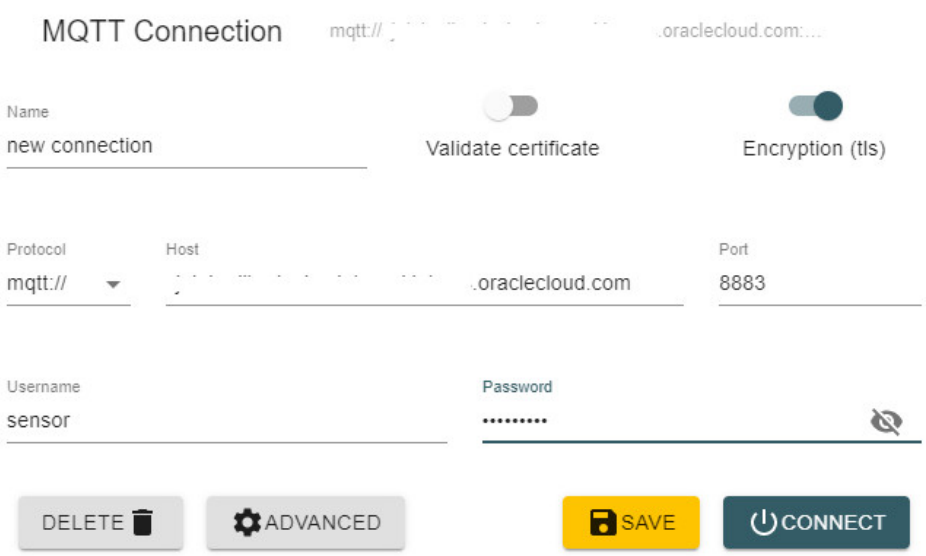
We choose a **JSON** schema and the **MQTTS (PUB)** protocol. We select the machine and choose to generate a sample payload for the sensor attribute. The entity ID (`sensor`) is included in the endpoint topic here, but you could also choose to include it as part of payload. We generate a sample schema for a single measurement.

The payload contains a sample value for the sensor attribute. Note that the sensor attribute ID (`4KGBM7VR2MA0`) that appears in the payload can be traced to its respective sensor name (`RPM`) in the machine editor.

> **Note:**
>
> The sample schema includes sensor attributes, and not control attributes. While sensor attribute values are generated in the device and passed to your IoT application, control attribute values can be passed back from your digital twin to the actual device.

When sending data, say using MQTT Explorer, copy the host, topic, and payload information from the Sample Schema dialog. Use the client ID as the user name and the secret, set earlier, to authenticate. Edit the payload, as required.

5. Send data for the device using an MQTT client.
   a. Configure the MQTT connection information.



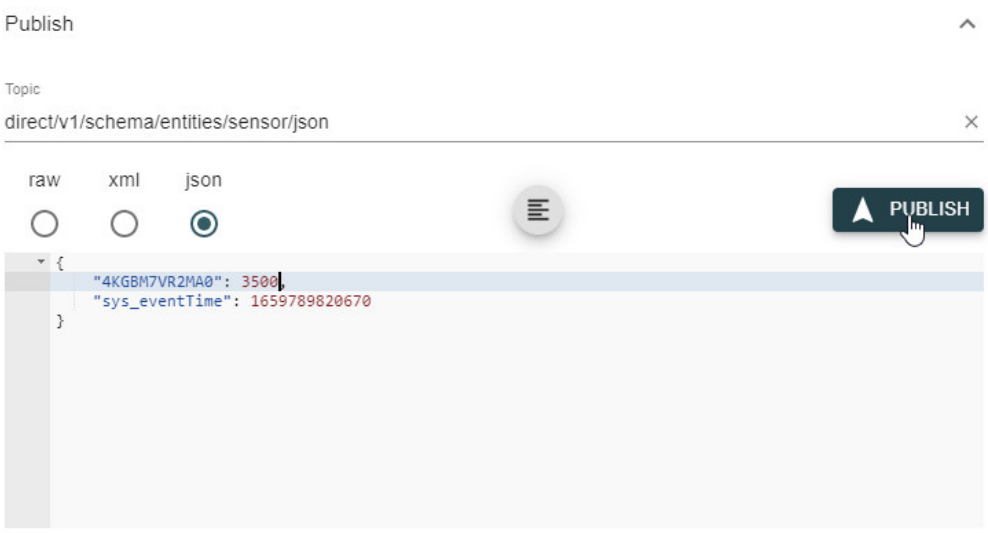
We use the host info that we copied from the sample schema dialog. Make sure that the encryption switch is ON, and use the secure port 8883. Use the external ID of the machine as the user name and the secret, set earlier, to authenticate.

b. Add a topic to be able to pass control attributes back to the device.

You can add the topic using one of the following formats:

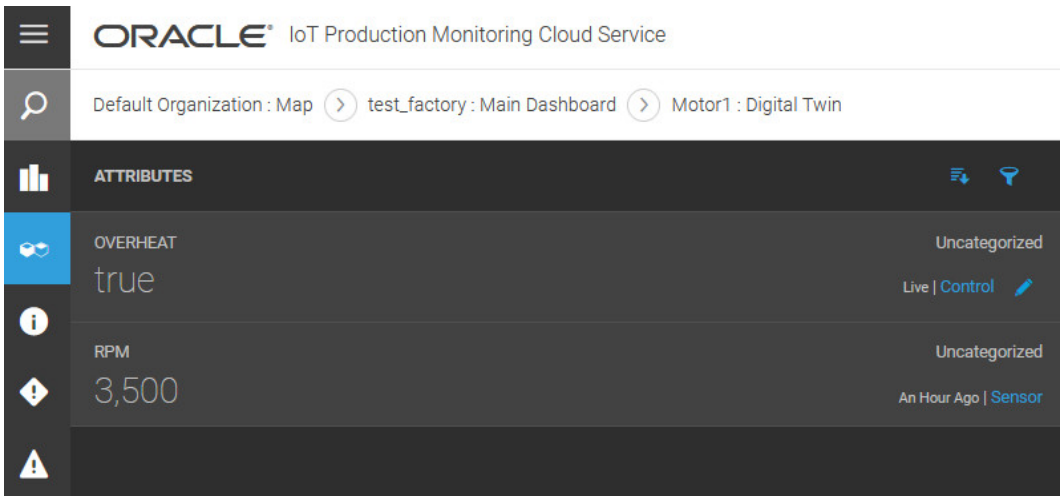
- `direct/v1/schema/#`
- `direct/v1/schema/entities/+/attributes/+`
- `direct/v1/schema/entities/+/attributes/attributeID`
- `direct/v1/schema/entities/externalID/attributes/attributeID`

c. Connect to the IoT server from the MQTT client, and publish device data to the server.



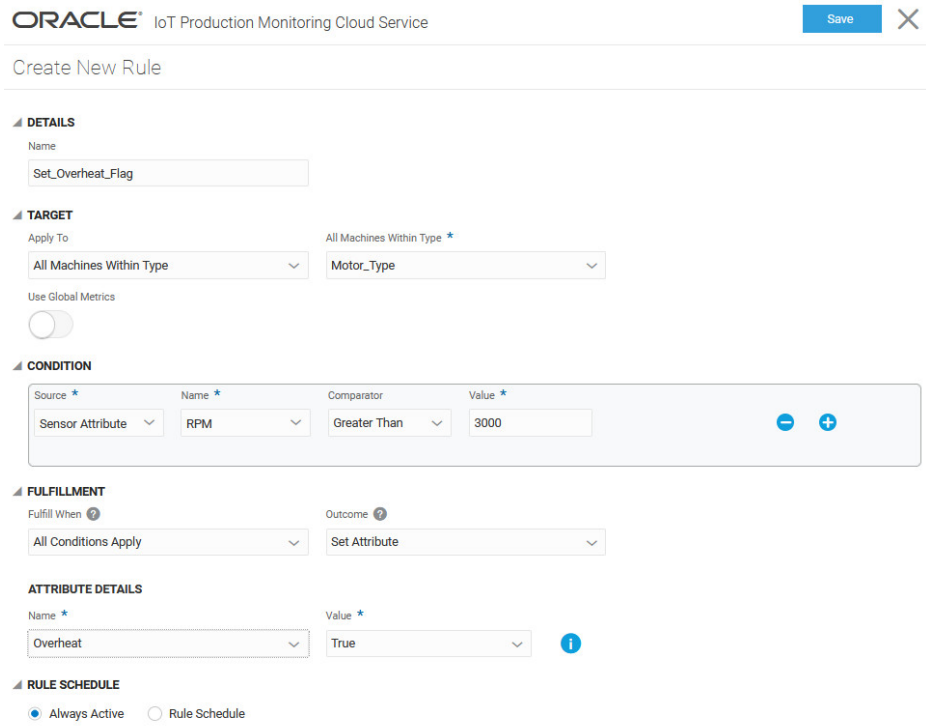
We use the topic and payload information copied from the Sample Schema dialog. We edit the payload values as necessary, and publish.

6. Verify that the published sensor data appears in Operations Center.



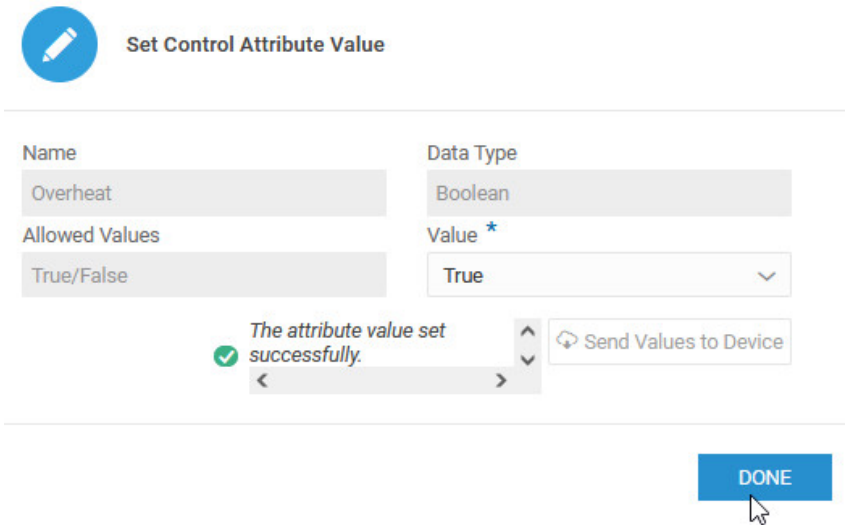
7. Send control data using a rule, or by manually editing the control attribute in Operations Center.

a. Use a rule to set the control attribute for a device.

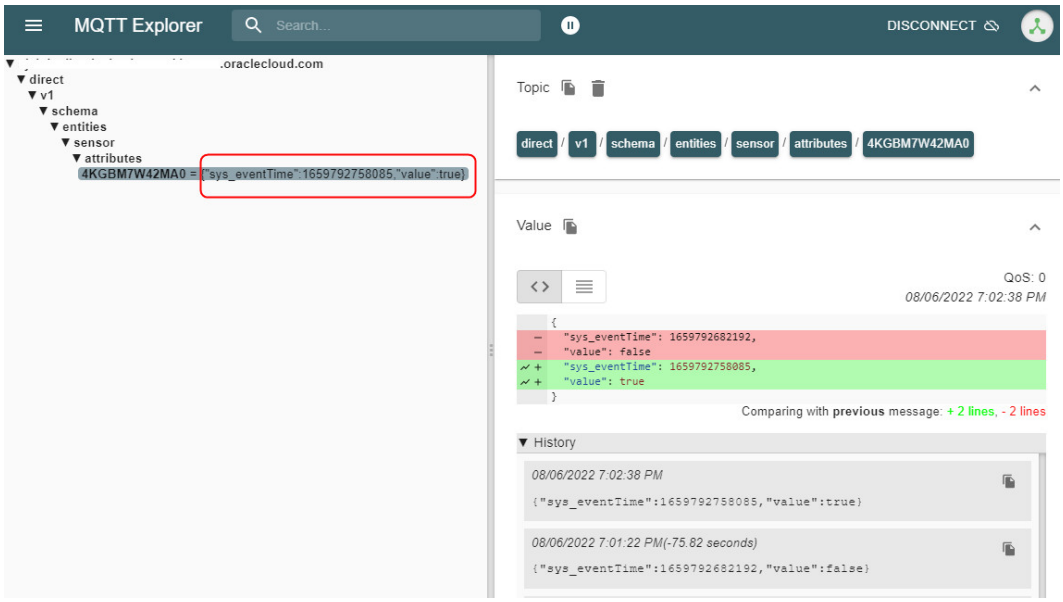


The preceding rule sets the `Overheat` control attribute to `true` if the RPM sensor value received from the IoT device is greater than 3000.

b. Alternatively, manually edit the control attribute in Operations Center, and send the data to the device.



You can check the control data received in your MQTT client.



Create Products

Manually define the products that you manufacture in your factories.

1. Click **Menu** and then click **Design Center**.
2. Select **Products** from the **Design Center** menu.
3. Click **Add** .
4. Enter an ID to identify this product.
5. (Optional) Enter a name, a description, and a category.
6. Click **Save**.
7. Click **Back** to return to the **Product** list.

Upload Production and Maintenance Data

Bulk upload the production and maintenance data for your factories using CSV files.

> **Note:**
>
> You can also upload production and maintenance data using REST APIs.

1. In Oracle IoT Production Monitoring Cloud Service, click **Menu** and then click **Design Center.**
2. Select **Organization** from the **Design Center** menu.
3. Click **Uploads** .

4. Click **Download a sample CSV file** for the data that you want to import.

   You can import data for the following business entities:

   - Production line
   - Production routing
   - Production plan
   - Actual production
   - Maintenance schedule
   - Machine

5. Using a text editor, edit the sample CSV file to specify the data for your factories.

   For information about the data in the CSV files, see Understand Production and Maintenance Data.

6. Click **Import**, then browse to the location where you stored the edited CSV file, select the file, and click **Choose**.

7. Click **View Data on Server** to verify that your data was correctly uploaded.

   If you are bulk uploading machine data, use the **Design Center > Machine Inventory** page to verify the data was correctly uploaded.

Understand Production and Maintenance Data

Bulk upload the production and maintenance data for your factories using CSV files.

Production Line

Define the arrangement of the machines used to manufacture a product. Your factory may have multiple production lines.

This table shows the fields and the descriptions for the CSV file to upload the data for the production lines in your factories:

Field	Description
Production Line ID	Enter an ID to identify this production line.
Production Line Name	Enter a name to identify the production line.
Factory ID	Enter the factory ID for the factory where the production line operates.
Machine ID	Enter the machine ID for the first machine in the production line.
Machine ID 2	Enter the machine ID for the second machine in the production line.
Ellipsis (...)	(Optional) Update the header to **Machine ID 3** and enter the machine ID for the third machine in the production line. If required, repeat this step in the next columns to add additional machines to the production line. The column heading for each additional machine must be unique.

Product Routing

Define the path that your products follow during the manufacturing process. Each line in this CSV file associates a certain product with a task and a machine.

This information is used to generate the product routing diagram for each product and production line in your factory.

This table shows the fields and the descriptions for the CSV file to upload the data for product routing in your factories:

Field	Description
productId	Enter the ID for the product produced using this product routing.
taskId	Enter a unique identifier for the routing task.
taskName	Enter a unique name for the routing task.
machineId	Enter the machine ID for the first machine that performs the first routing task.
Ellipsis (...)	(Optional) Update the header to **Machine ID 2** and enter the machine ID for the second machine that performs a secondary routing task. If required, repeat this step in the next columns to add additional machines. The column heading for each additional machine must be unique.

Production Plan

Define the expected production rated for a product in a factory, a production line, or a machine in a certain period.

This table shows the fields and the descriptions for the CSV file to upload the production plan:

Field	Description
Start Time	(Required) Enter the start time and date for the production plan. Use the format `YYYY-MM-DDTHH:MM:SS`. For example, 2016–03–14T17:09:02 for March 14th, 2016 at 5:09:02 PM
End Time	(Required) Enter the end time and date for the production plan. Use the format `YYYY-MM-DDTHH:MM:SS`. For example, 2016–03–15T18:30:05 for March 15th, 2016 at 6:30:05 PM
Product ID	(Required) Enter the ID for the product manufactured using this production plan.
Factory ID	(Optional) Enter the ID for the factory where the product is produced. If this is the only optional field specified, all products produced by the specified factory are used to determine the production quantity. If you enter a **Factory ID** value, you must not enter values for the **Production Line ID**, **Routing Task ID**, or **Machine ID** fields.
Production Line ID	(Optional) Enter the ID for the production line that produces the product. If you only specify this field, then only the products produced by the specified production line are used to determine the production quantity. If you enter a value for the **Production Line ID** field, then you must not enter values for the**Routing Task ID** or **Machine ID** fields.
Routing Task ID	(Optional) Enter the ID for the routing task associated with the product. If you only specify this field, then only the products produced by the specified routing task are used to determine the production quantity. If you enter a value for the **Routing Task ID** field, then you must also enter a value for the **Machine ID** or **Operator ID** fields.
Machine ID	(Optional) Enter the ID for the machine that produces the product. If you specify this field, then only the products produced by the specified machine are used to determine the production quantity. If you enter a value for the **Machine ID** field, then you must also enter a value for the **Routing Task ID** field.

Field	Description
Operator ID	(Optional) Enter the ID for the assigned operator. This is the user name (Login ID) of the operator. If you specify this field, then only the products produced by the specified operator are used to determine the production quantity. If you enter a value for the **Operator ID** field, then you must also enter a value for the **Routing Task ID** field.
Quantity	(Required) Enter the expected product quantity for the production plan. This value defines the number of products that you expect to produce in the specified period.

Actual Production

Upload the actual production for a product in a factory, a production line, or a machine in a certain period.

This table shows the fields and the descriptions for the CSV file to upload the actual production for your factories:

Field	Description
Start Time	(Required) Enter the start time and date for the actual production plan. Use the format `YYYY-MM-DDTHH:MM:SS`. For example, 2016–03–14T17:09:02 for March 14th, 2016 at 5:09:02 PM
End Time	(Required) Enter the end time and date for the actual production plan. Use the format `YYYY-MM-DDTHH:MM:SS`. For example, 2016–03–15T18:30:05 for March 15th, 2016 at 6:30:05 PM
Product ID	(Required) Enter the ID for the product for which you are specifying the actual production..
Factory ID	(Optional) Enter the ID for the factory that manufactures this product. If you only specify this optional field, then all products produced by the specified factory are used to determine the production quantity. If you enter a value for the **Factory ID** field, then you must not enter values for the **Production Line ID**, **Routing Task ID**, or **Machine ID** fields.
Production Line ID	(Optional) Enter the ID for the production line that produces the specified product. If you only specify this optional field, then only the products produced by this production line are used to determine the production quantity. If you enter a value for the **Production Line ID** field, then you must not enter a value for the **Routing Task ID** or **Machine ID** fields.
Routing Task ID	(Optional) Enter the ID for the routing task associated with the product. If you only specify this optional field, then only the products manufactured in this routing task are used to determine the production quantity. If you enter a value for the **Routing Task ID** field, then you must also enter a **Machine ID** or **Operator ID** field.
Machine ID	(Optional) Enter the ID for the machine that manufactures the specified product. If you only specify this optional field, then only the products produced by the specified machine are used to determine the production quantity. If you enter a value for the **Machine ID** field, then you must also enter a value for the **Routing Task ID** field.
Operator ID	(Optional) Enter the ID (user name) for the operator that manufactures the specified product. If you only specify this optional field, then only the products produced by the specified operator are used to determine the production quantity. If you enter a value for the **Operator ID** field, then you must also enter a value for the **Routing Task ID** field.

Field	Description
Completed Quantity	(Required) Enter a value representing the actual quantity of the product produced. At least one of **Completed Quantity**, **Reject Quantity**, or **Scrap Quantity** must be non-zero.
Reject Quantity	(Optional) Enter a value representing the number of reject items produced. Reject quantities may eventually be scrapped or completed. At least one of **Completed Quantity**, **Reject Quantity**, or **Scrap Quantity** must be non-zero.
Scrap Quantity	(Optional) Enter a value representing the number of scrapped items produced. Scrapped quantities cannot be completed. At least one of **Completed Quantity**, **Reject Quantity**, or **Scrap Quantity** must be non-zero.
Reject Reason	(Optional) Enter a justification for the reject quantities.
Scrap Reason	(Optional) Enter a justification for the scrap quantities.
Reject Details	(Optional) Enter more details about the reject quantities, such as serial number information.
Scrap Details	(Optional) Enter more details about the scrap quantities, such as serial number information.
Work Order Number	(Optional) If the production plan was created in response to a work order from Oracle Fusion Cloud Manufacturing, then enter the work order number here.

Maintenance Schedule

Schedule maintenance for the machines in your factory.

This table shows the fields and the descriptions for the CSV file to upload maintenance schedules:

Field	Description
Machine ID	Enter the ID for the machine that requires maintenance.
Start Time — End Time	Enter the start and end time for the maintenance work. Use this format: YYYY-MM-DDTHH:MM:SS~YYYY-0MM-DDTHH:MM:SS. For example, `2016-03-14T17:30:10~2016-03-15T17:30:10`, indicates this machine is unavailable due to maintenance for 24 hours starting March 14th, 2016 at 5:30:10 PM.
Start Time 2 — End Time 2	(Optional) Enter a second maintenance period.
Ellipsis (...)	(Optional) Update the header to **Start Time 3— End Time 3** and enter a third maintenance period. If required, repeat this step in the next columns to add additional maintenance periods. The column heading for each additional maintenance period must be unique.

Machine

Bulk upload the data for the machines in your factories using a CSV file.

This table shows the fields and the descriptions for the CSV file to bulk upload machines:

Field	Description
Machine ID	(Required) Enter the ID that identifies this machine.
Machine Name	(Optional) Enter the name of this machine. If you don't specify a name, the **Map** view displays the ID below the machine icon.
Machine State	(Optional) Enter the current status of the machine. Available options are: **In Use**, **Idle**, **Down**.
Machine Type	(Optional) Enter the machine type for this machine. The machine type defines the icon and device model this machine uses.
Factory ID	(Required) Enter the ID for the factory where this machine is located.
Attributes	(Optional) The list of additional attributes for this machine. The additional attributes depend on the machine type you selected. Specify the name of the attribute followed by a comma and the value for this attribute. For example, if the machine type you selected specifies the additional attributes manufacturer and installation date then you can add `manufacturer,ACME,installation_date,2011-01-11T03:00:00`.

Import Historical Sensor and Metric Data for Machines

If you have your pre-deployment device data in an external system, you can choose to import historical sensor and metric data into Oracle IoT Production Monitoring Cloud Service and use the data to train your analytics artifacts, such as anomalies and predictions.

Importing historical data is useful for cold start scenarios where you don't have training data already available in Oracle IoT Production Monitoring Cloud Service. You can also import data for proof-of-concept demonstrations, so that you can use the imported data to train your anomalies, predictions, and trends.

> **Note:**
>
> Pattern anomalies do not support imported historical data. To create pattern anomalies, you must generate training data in Oracle IoT Production Monitoring Cloud Service.

Use the following steps to import historical sensor and metric data into Oracle IoT Production Monitoring Cloud Service:

1. In Oracle IoT Production Monitoring Cloud Service, create and export a machine data template for your machine's data.
2. Populate the machine data template with sensor and metric data from the external system.
3. Import the machine data into Oracle IoT Production Monitoring Cloud Service. The data is available for training after validation and processing.

Export the Machine Data Template

The machine data template defines the schema for your machine data import. It includes fields for machine names and IDs, timestamps, sensor attributes, and metrics.

You should have your machine type, sensor attributes, metrics, and machines created in Oracle IoT Production Monitoring Cloud Service before creating the machine data template.

1. Log in to Oracle IoT Production Monitoring Cloud Service as an administrator.

   Only administrators have the privilege to export machine data templates from Oracle IoT Production Monitoring Cloud Service.

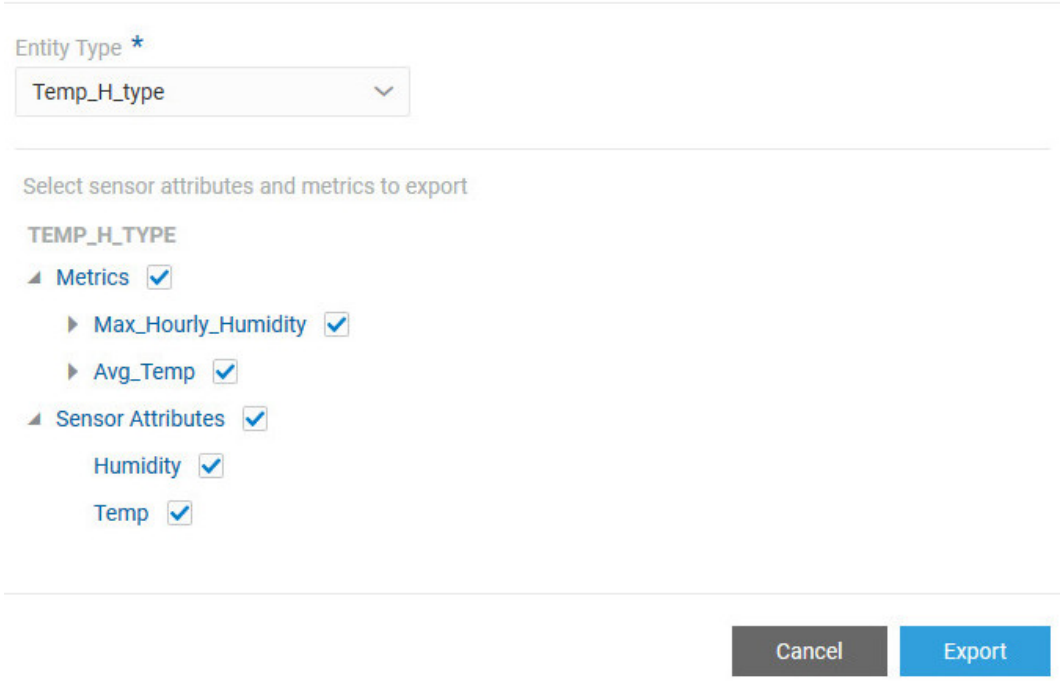
2. Click **Menu** (☰), and then click **Design Center**.
3. Select **Machines** from the **Design Center** sub-menu.
4. Click the Machine Inventory Menu ••• and select **Export Machine Data Template**.
5. Select the **Entity Type** (Machine Type) for the machine data template.

   For example, you may want to create a machine data template for a combustion engine.

   The existing sensor attributes and metrics for the machine type appear in a tree-like structure under the machine type.

6. Deselect the sensor attributes and metrics that you do not wish to include in your machine data template.

   For example, if you do not have historical data for a particular attribute in your external system, you can exclude it from the machine data template.



   You can click on the **Sensor Attributes** and **Metrics** nodes to expand or collapse them.

7. Click **Export**.

Save the exported `csv` (comma separated value) file to your local storage.

The exported `csv` file contains the following fields:

- `ora_entity_type_name`: The entity type (machine type) for which you created the template.
- `ora_entity_name`: Name of the entity (machine). You must specify at least one of `ora_entity_name, ora_entity_id, and ora_external_entity_id` for each row of data that you populate in the machine data template.
- `ora_entity_id`: Identifier (ID) of the entity (machine). You must specify at least one of `ora_entity_name, ora_entity_id, and ora_external_entity_id` for each row of data that you populate in the machine data template.
- `ora_external_entity_id`: External Identifier of the entity (machine). An external identified would be the identifier of an imported machine in the external system from which it was imported. For example, the resource instance ID of a machine in Oracle Fusion Cloud Manufacturing.
  You must specify at least one of `ora_entity_name, ora_entity_id, and ora_external_entity_id` for each row of data that you populate in the machine data template.
- `ora_event_time`: The event time against which the telemetry data is being reported. The epoch long time format and ISO 8061 format are supported.
- `ora_sensor.`*`name`* fields: The sensor attribute values for the attributes that you included in your template.
- `ora_metric.`*`name`* fields: The metric values for the attributes that you included in your template.

Import Machine Data for Sensors and Metrics

Once you have populated your machine data template with machine data, you can import the `csv` file, or a `zip` file containing one or more `csv` files, into Oracle IoT Production Monitoring Cloud Service.

1. Log in to Oracle IoT Production Monitoring Cloud Service as an administrator.

   Only administrators have the privilege to import historical machine data into Oracle IoT Production Monitoring Cloud Service.
2. Click **Menu** (☰), and then click **Design Center**.
3. Select **Machines** from the **Design Center** sub-menu.
4. Click the Machine Inventory Menu ⋯ and select **Import Machine Data**.
5. Enter an **Import Task Description** to help you identify the import task later.
6. Select the **Entity Type** (Machine Type) for the machine data that you are importing.
7. Optionally change the number of data lines under **Rejection Threshold**.

   The **Rejection Threshold** specifies the threshold number of erroneous data lines in the imported file before the import is rejected. Typically, users populate the machine data template using an automated process, so if a certain number of data lines are erroneous, it is very likely that the rest of the lines are erroneous too. Oracle IoT Production Monitoring Cloud Service halts the import once the specified threshold is reached.

A data line may be rejected for various reasons. For example, the data line might have missing or incorrect entity information.

8. (Optional) Deselect **Review errors before processing** if you wish the file to be auto processed or rejected without prompting you to review the errors, if any.

   Review errors before processing lets you review the error details in case there are validation errors in the imported file. If the number of erroneous rows are below the threshold, you can choose to process or reject the remaining rows.

   If you deselect **Review Errors Before Processing**, then if the number of errors is below the rejection threshold, the import is auto-processed. Else the import is rejected.

9. Click **Choose File** and select the `csv` file or `zip` file to be imported.

   The maximum file size cannot exceed 150 MB. You can choose to compress multiple `csv` files in a single `zip` file.

10. Click **Continue**.

    A notification appears confirming that the upload request was sent.

    The imported file is next validated and processed after which the imported data is available for training. If you are working in other areas of the application, you get periodic notifications about the status of the import. You are also notified if data errors are found in the import file.

11. (Optional) Click the **Data Import Log** tab to monitor the status of the import.

    The Initiated column reflects the time when the import request was initiated.

    The Status column reflects the current status of the import. The status column may reflect one of the following:

    - **Pending Validation:** This is the status just after you have initiated the import.
    - **Validating Data:** The data validation is in progress for the imported file.
    - **Processing Trained Data:** The data processing stage follows the validation stage.
    - **Historical Data Available:** The training data is available in the system.
    - **Some Data Errors Found**: Indicates that there were data errors while processing.

      You can click the **Show Details** icon to view the error details. Click **Action Required** to accept or reject the remaining rows.
    - **Request Rejected**: The reason for request rejection is enumerated. For example, the machine data template had a bad schema, or the number of erroneous rows exceeded the rejection threshold. You can click the **Show Details** icon to view the rejection details.

    a. Click the **Show Details** icon to view details about the import, such as any error or rejection details.

    b. Click **OK**.

    c. Click **Action Required** to complete any user-pending tasks, such as the following:

       - **Process historical data ignoring errors**
       - **Reject Request**

If you have chosen to review errors before processing, and if the number of erroneous rows are below the rejection threshold, then you can choose to process the historical data in the remaining rows. You can also choose to reject the import request.

d. Click **OK**.

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Configure Your Devices

Configure the sensor devices in your factory to work with Oracle IoT Production Monitoring Cloud Service.

How to Connect Sensors to Your Application

Before using or uploading data to Oracle IoT Production Monitoring Cloud Service you must connect to your application the sensors that you are using to monitor your machines.

To follow this procedure you need access to an Oracle Internet of Things Intelligent Applications Cloud instance. Typically the URL has the form `http://hostname/ui`. The credentials are the same credentials you use for Oracle IoT Production Monitoring Cloud Service.

Using Oracle Internet of Things Intelligent Applications Cloud:

1. Create the device model for your sensors.

   See Create a Device Model

2. Register your sensors.

   See Register a Single Device and Register a Batch of Devices

3. Activate your sensors.

   See Activate a Device and Activate a Batch of Devices.

Using Oracle IoT Production Monitoring Cloud Service:

4. Associate the device model with a machine type:
   a. Create or edit a machine type.

      For information on how to create a machine type, see Create Machine Types.

   b. In the **Device Model** section, click **Create New** .
   c. Enter a name to identify this device model.
   d. (Optional) In the **Instructions** field, enter a description.
   e. (Optional) Select **Required** if it's mandatory to define a device that uses this device model when creating a new machine.
   f. From the **Device Model** list, select the device model you want to assign to this machine type.
   g. Click **OK**.
5. Associate a specific sensor with a specific machine:
   a. Create or edit a machine.

      For information on how to create a machine, see Create Machines.

   b. In the **Sensor Device** section, click **Find Device** for the device model that corresponds to the sensor you want to associate to this machine.

c. From the **Property** list, select a search parameter to search for this sensor, then enter the value for this search parameter, and click **Go**.

   The available sensors appear in the list below the search fields.

d. Select a sensor from the list.

e. Click **Select**.

Create a New Device Model

A device model is an interface that lets any device communicate with Oracle Internet of Things Intelligent Applications Cloud regardless of its manufacturer or operating system.

1. Open the Oracle Internet of Things Intelligent Applications Cloud Management Console.

   You can access the Oracle Internet of Things Intelligent Applications Cloud Management Console from the following URL:

   `https://hostname/ui`

   Here, *hostname* is the host name of your Oracle Internet of Things Intelligent Applications Cloud instance.

2. Click the **Menu** () icon.
3. Select **Devices** and then select **Model**.
4. Select one of these options:
   - If you have not previously created a device model, click **Create Device Model**.
   - If you have previously created a device model, click the **Add** () icon.
5. Complete these fields:
   a. **Name**: Enter a name for the device model.
   b. **Description**: Enter an optional description for the device model.
   c. **URN**: Enter a unique identifier for the device model. Use this format: `urn:com:<mycompany>:<mydevice>:<what the device model does>`.
6. Select system attributes for the device model.
7. (Optional) Add custom attributes for the device model:
   a. Expand the **Custom Attributes** option list.
   b. Click the **Add** () icon.
   c. Enter a name for the custom attribute in the **Name** field.
   d. Enter an optional description for the custom attribute in the **Description** field.
   e. Select a data type in the **Type** list.
   f. Select **Writable** if you want to make the custom attribute writable.
   g. Click **OK**.
8. (Optional) Define the actions that can be invoked on the device:
   a. Expand the **Actions** option list.

b. Click the **Add** (⊕) icon.

c. Enter a name for the action in the **Name** field.

d. Enter an optional description for the action in the **Description** field.

e. Select the data type for the action in the **Arguments** list.

f. Enter an optional alternate name for the action in the **Alias** field.

g. Click **OK**.

9. (Optional) Create alerts and custom message formats for the device model:

a. Expand the **Alerts and Custom Messages** option list.

b. Click the **Add** (⊕) icon.

c. Enter a name for the alert or custom message in the **Name** field.

d. Enter an optional description for the alert or custom message in the **Description** field.

e. Enter a unique identifier for the alert or custom message in **URN** field. Use this format:`urn:<mycompany>:<department>:<mydevice>:<device model>:<message>`.

f. Select a data type in the **Type** list.

g. Click **OK**.

h. Select the alert message format and then click the **Add** (⊕) icon in the **Fields** column.

i. Enter a name for the message type in the **Name** field.

j. Select a data type in the **Type** list.

k. Select **Optional** to indicate the field value can be missing in the device model message format.

l. Click **OK**.

10. Click **Save**.

Predefined Device Models

Oracle IoT Production Monitoring Cloud Service provides predefined device models to report the state of a machine or the production output for a product.

The following Oracle IoT Production Monitoring Cloud Service device models are included in Oracle Internet of Things Intelligent Applications Cloud:

- **Machine State (`ProductionMonitoringMachineState`)**
  A sensor attached to your machine can use this device model to report the state of the machine to Oracle Internet of Things Intelligent Applications Cloud. The states can be one of the following:
  - `INUSE`
  - `DOWN`
  - `IDLE`

  If the sensors connected to the machine are not capable of reporting the state themselves, a connected gateway device can be used to report on behalf of the sensor.

The device model specification is as follows:

```
{
  "urn": "urn:com:oracle:iot:pm:machine_state",
  "name": "Production Monitoring Machine State device model",
  "description": "Machine state device model",
  "system": true,
  "attributes" : [
     {
       "name" : "state",
       "description" : "Machine state enum. This is one of INUSE,
DOWN or IDLE",
       "type": "STRING",
       "writable" : false
     },
     {
       "name" : "machine",
       "description" : "Machine Unique Identifier",
       "type": "STRING",
       "writable" : false
     }
  ]
}
```

The following table describes the attributes used in the device model:

Attribute	Type	Description	Required	Default Value
machine	String	The identifier of the machine for which the state information is being reported. Populated only if the message is sent by a gateway on behalf of the machine. If a device that implements this device model is associated with the machine (as a device attribute), then *machineId* is derived from the device's *sourceId*.	No	none
state	String	The physical state of the machine: – INUSE: Machine is up and running, and is actively producing a product. – DOWN: Machine is not running; could be down on account of a scheduled maintenance, outage, or hardware failure. – IDLE: Machine is running, but not actively producing any product.	Yes	none

- **Production Output (`ProductionMonitoringProductionOutput`)**

Use this device model to report the production output for a product for the specified time period. The device model specification is as follows:

```
{
    "urn": "urn:com:oracle:iot:pm:production_output",
    "name": "Production Monitoring Production Output device model",
    "description": "Production Output device model",
    "system": true,
    "attributes" : [
        {
            "name" : "startTime",
            "description" : "Start time of the production output. This is
specified as a Long value in milliseconds since epoch (Jan 1 1970)",
            "type": "DATETIME",
            "writable" : false
        },
        {
            "name" : "endTime",
            "description" : "End time of the production output. This is
specified as a Long value in milliseconds since epoch (Jan 1 1970). The
value should be greater than the startTime attribute.",
            "type": "DATETIME",
            "writable" : false
        },
        {
            "name" : "product",
            "description" : "Product Identifier that was produced.",
            "type": "STRING",
            "writable" : false
        },
        {
            "name" : "quantity",
            "description" : "Quantity of the product produced. This
should be within the range [1,Integer.MAXINT] (both inclusive)",
            "type": "INTEGER",
            "writable" : false
        },
        {
            "name" : "factory",
            "description" : "Factory where the product was produced. The
value specified should be a registered factory identifier.",
            "type": "STRING",
            "writable" : false
        },
        {
            "name" : "productionLine",
            "description" : "Production Line within the factory where the
product was produced. The value specified should be a registered
production line identifier.",
            "type": "STRING",
            "writable" : false
        },
        {
            "name" : "routingTask",
            "description" : "The routing task associated with the
```

```
produced product. The value specified should be a registered
routing task identifier.",
            "type": "STRING",
            "writable" : false
        },
        {
            "name" : "machine",
            "description" : "The machine which produced the
product. The value specified should be a registered machine
identifier.",
            "type": "STRING",
            "writable" : false
        }
    ]
}
```

The following table describes the attributes used in the device model:

Attribute	Type	Description	Required	Default Value
startTime	DateTime	Start time of the production output, specified as a `Long` value in milliseconds since epoch (Jan 1 1970).	Yes	none
endTime	DateTime	End time of the production output, specified as a `Long` value in milliseconds since epoch (Jan 1 1970). The value should be greater than the *startTime* attribute.	Yes	none
product	String	Product identifier for the product that was produced.	Yes	none
quantity	Integer	Quantity of the product produced. This should be within the range `[1,Integer.MAXINT]` (both inclusive).	Yes	none
factory	String	Factory where the product was produced. The value specified should be a registered factory identifier.	No At least one of factory, productionLine, routingTask, or machine is required.	none
productionLine	String	Production line within the factory where the product was produced. The value specified should be a registered production-line identifier.	No At least one of factory, productionLine, routingTask, or machine is required.	none

Attribute	Type	Description	Required	Default Value
routingTask	String	The routing task associated with the product. The value specified should be a registered routing-task identifier.	No At least one of factory, productionLine, routingTask, or machine is required.	none
machine	String	The machine which produced the product. The value specified should be a registered machine identifier.	No At least one of factory, productionLine, routingTask, or machine is required.	none

Register a Single Device

To communicate with Oracle Internet of Things Cloud Service, every device that is connected to Oracle Internet of Things Cloud Service must be registered and then activated. All devices are registered as a Directly Connected Device (DCD). During activation, the device indicates support for indirect enrollment. A device indicating indirect enrollment capability is automatically changed from DCD to gateway.

1. Click the **Menu** (☰) icon adjacent to the Oracle Internet of Things Cloud Service title on the Management Console.
2. Click **Devices**.
3. Click **Registration**.
4. Click **Register Single Device**.
5. Complete the optional and mandatory fields.

> **Note:**
>
> If you leave the **Activation Secret** field blank, a value is auto-generated and displayed when the device registration is confirmed. You can enter your own Activation Secret value. Any additional information, such as Name, Description, and Metadata are optional, but can be useful as search criteria when managing your registered devices.

6. Click **Register**.
7. Enter a password in the **File Protection Password** field to encrypt the provisioning file that contains the configuration and credentials to activate your device.
8. Enter the password again in the **Confirm Password** field.
9. Download the provisioning file:
   a. Click **Download Provisioning File**.
   b. Click **Save File**.

c. Click **OK**.

d. Browse to a location to save the provisioning file.

e. Click **Save**.

10. Click **Finish**.

Register a Batch of Devices

Registering a batch of devices reduces the time required to register multiple devices. You create a comma-separated values (CSV) file to define the settings for each device. You upload the CSV file to Oracle Internet of Things Intelligent Applications Cloud.

To view the information that you should include in the CSV file, see About CSV Batch Registration File Properties.

1. Click the **Menu** (☰) icon adjacent to the Oracle Internet of Things Intelligent Applications Cloud title on the Management Console.
2. Click **Devices**.
3. Click **Registration**.
4. Select one of these options:
   - Click **Download CSV template** to download a CSV template that you can complete.

     > **Note:**
     >
     > The CSV file contains the mandatory and optional property values for each device. If a value is not provided for the optional properties, insert a comma to indicate that a value is not provided. In the last line of the sample CSV file, a comma indicates that property values are not provided for `ActivationId` and `Activation Secret`
   - Click **Batch Registration** to upload an existing CSV file.
5. Click **Browse** and browse to the CSV file that contains the registration information for the devices you are registering.
6. Click **Next** when the CSV registration file is successfully uploaded.

   If the Review page contains a warning (⚠) icon, select one of these options:
   - **Update** - Choose this option if you want to update the information for an existing registered device. The registered device has the same manufacturer, model and serial number as one of the devices listed in the CSV registration file.
   - **Ignore** - Choose this option if you do not want to include the device in the current registration process.
7. Click one of these options:
   - **Next**: Click to proceed to register the items in the CSV registration file that have been identified as being viable candidates for registration.

- **Cancel**: Click to discontinue the batch registration process.

8. Enter a password in the **File Protection Password** field to encrypt the provisioning file that contains the configuration and credentials to activate your device.
9. Enter the password again in the **Confirm Password** field.
10. Download the provisioning file:
    a. Click **Download Provisioning File**.
    b. Click **Save File**.
    c. Click **OK**.
    d. Browse to a location to save the provisioning file.
    e. Click **Save**.
11. Click **Finish**.
12. Activate the registered devices to begin a secure communication between the devices and Oracle Internet of Things Intelligent Applications Cloud. See Activate a Batch of Registered Devices.

About CSV Batch Registration File Properties

The following table provides descriptions of the properties that appear in the Comma Separated Values (CSV) file used to register a batch of devices with Oracle Internet of Things Intelligent Applications Cloud. Mandatory and optional values are described in the table and are listed in the order they are expected to appear in the CSV file.

To register a batch of devices with Oracle Internet of Things Intelligent Applications Cloud, see Registering a Batch of Devices.

Property	Required / *Optional*	Description
`Name`	*Optional*	The `String` data type assigned to the registered device. This value can be modified after device registration.
`Manufacturer`	**Required**	The manufacturer of the device.
`Model Number`	**Required**	The model number of the device
`Serial Number`	**Required**	The serial number of the device.
`Activation ID`	*Optional*	A Device Unique Identifier (UID) that is required for device activation. If a value is not specified, an auto-generated value is assigned to the device after a successful registration. The value cannot be changed after the device is successfully registered.
`Activation Secret`	*Optional*	The Activation Secret (also known as Shared Secret) value required to activate your device. If a value is not specified, an auto-generated string value is assigned to the device after a successful registration. This value is available after a successful registration. This value can be modified before you modify your device.

Property	Required / *Optional*	Description
`Latitude`	*Optional*	The decimal notation of the latitude of the device's position. For example: -43.5723 [World Geodetic System 1984]. If you specify the latitude, then you must also specify the longitude.
`Longitude`	*Optional*	The decimal notation of the longitude of the device's position. For example: , e.g. -43.5723 [World Geodetic System 1984]. If you specify the longitude, then you must also specify the latitude.
`Altitude`	*Optional*	The decimal notation of the altitude of the device's position, in meters above sea level.
`Accuracy`	*Optional*	The accuracy of the device's position in meters. This must be a positive number or zero. An accuracy value can only be specified if the latitude and longitude are provided.
`Metadata`	*Optional*	Key/value pairs that are listed in successive columns. There must be an even number of columns containing keys and values. If there is an odd number of columns, an error message is returned.

Activate a Device

A device can be activated after it is registered and an application has been created and run on the device. During activation, the device indicates support for indirect enrollment. A device indicating indirect enrollment capability is automatically changed from DCD to Gateway.

1. Register your directly connected device. See Registering a Single Device.
2. Create an application for the device using the Oracle Internet of Things Intelligent Applications Cloud Client Software Library APIs. See Developing Device Software Using the Client Software Libraries.

   When using the Java Client Library, for example, use the following steps to initialize and activate the device:

   a. Add this statement to the device application code to initialize the device:

   ```
   DirectlyConnectdDevice dcd = new
   DirectlyConnectedDevice(configFilePath, configFilePassword);
   ```

   b. Add this statement to the device application code to activate the device:

   ```
   if (!dcd.isActivated())
   { dcd.activate(deviceModelUrn); }
   ```

3. Verify the device has been activated:

   a. Open the Oracle Internet of Things Intelligent Applications Cloud Management Console.

b. Click the **Menu** (☰) icon adjacent to the Oracle Internet of Things Cloud Service title on the Management Console.

c. Click **Devices**.

d. Click **Management**.

e. Locate the device in the device table or use the **Property** and **Value** fields at the top of the table to search for a specific device.

f. Verify `Activated` and not `Registered` is displayed in the **State** column.

Activate a Batch of Registered Devices

After you've registered a batch of devices, you need to activate the devices before they can securely communicate with Oracle Internet of Things Intelligent Applications Cloud.

1. Register the devices and download the provisioning file. See Registering a Batch of Devices.
2. Activate each of the registered devices. See Activate a Device.
3. Verify that each of the registered devices has been activated.
   a. Open the Oracle Internet of Things Intelligent Applications Cloud Management Console.
   b. Click the **Menu** (☰) icon adjacent to the Oracle Internet of Things Cloud Service title on the Management Console.
   c. Click **Devices**.
   d. Click **Management**.
   e. Locate the device in the device table or use the **Property** and **Value** fields at the top of the table to search for a specific device.
   f. Verify `Activated` and not `Registered` is displayed in the **State** column.