Configure dataflows in Azure IoT Operations

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> **Important**
>
> This page includes instructions for managing Azure IoT Operations components using Kubernetes deployment manifests, which is in **preview**. This feature is provided with several limitations, and shouldn't be used for production workloads.
>
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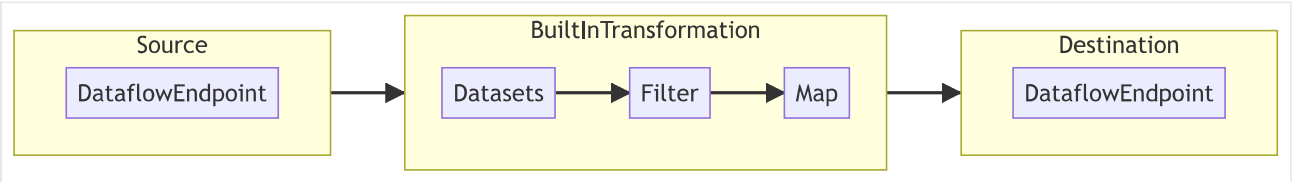
A dataflow is the path that data takes from the source to the destination with optional transformations. You can configure the dataflow by creating a *Dataflow* custom resource or using the Azure IoT Operations Studio portal. A dataflow is made up of three parts: the **source**, the **transformation**, and the **destination**.



To define the source and destination, you need to configure the dataflow endpoints. The transformation is optional and can include operations like enriching the data, filtering the data, and mapping the data to another field.

> **Important**
>
> Each dataflow must have the Azure IoT Operations local MQTT broker default endpoint as *either* the source or destination.

You can use the operations experience in Azure IoT Operations to create a dataflow. The operations experience provides a visual interface to configure the dataflow. You can also use Bicep to create a dataflow using a Bicep template file, or use Kubernetes to create a dataflow using a YAML file.

Continue reading to learn how to configure the source, transformation, and destination.

Prerequisites

You can deploy dataflows as soon as you have an instance of Azure IoT Operations using the default dataflow profile and endpoint. However, you might want to configure dataflow profiles and endpoints to customize the dataflow.

Dataflow profile

If you don't need different scaling settings for your dataflows, use the default dataflow profile provided by Azure IoT Operations. To learn how to configure a dataflow profile, see Configure dataflow profiles.

Dataflow endpoints

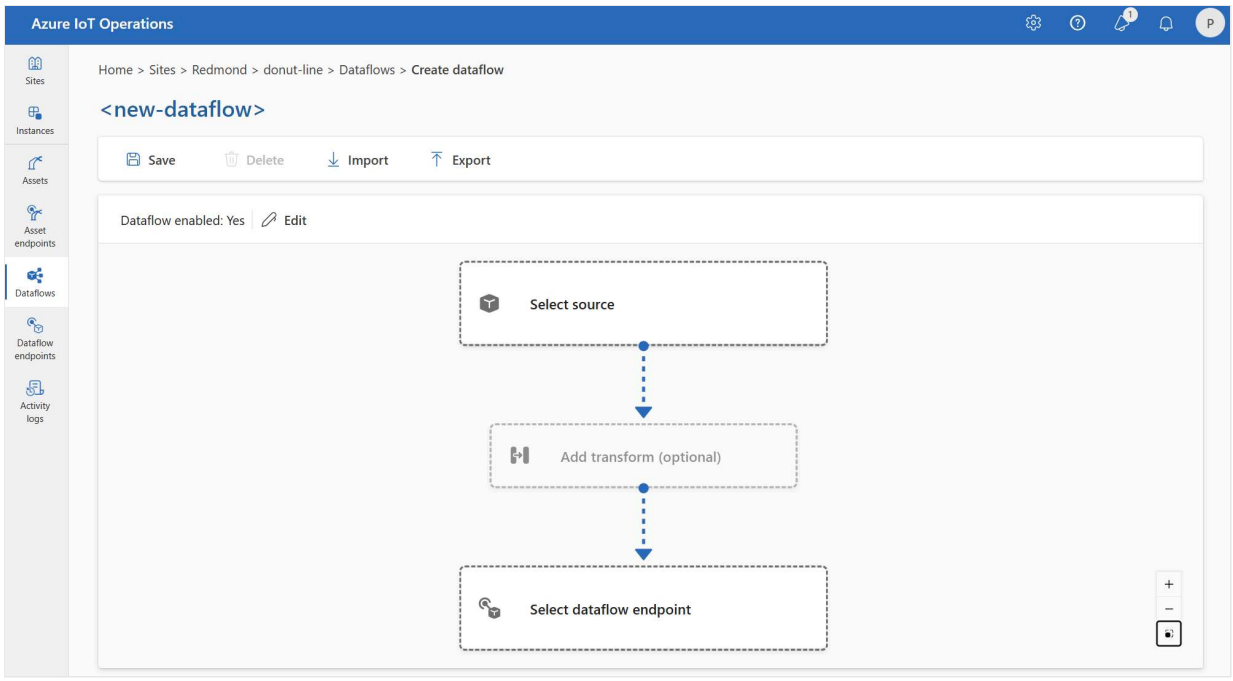
Dataflow endpoints are required to configure the source and destination for the dataflow. To get started quickly, you can use the default dataflow endpoint for the local MQTT broker. You can also create other types of dataflow endpoints like Kafka, Event Hubs, or Azure Data Lake Storage. To learn how to configure each type of dataflow endpoint, see Configure dataflow endpoints.

Get started

Once you have the prerequisites, you can start to create a dataflow.

Portal

To create a dataflow in operations experience , select **Dataflow** > **Create dataflow**. Then, you see the page where you can configure the source, transformation, and destination for the dataflow.



Review the following sections to learn how to configure the operation types of the dataflow.

Source

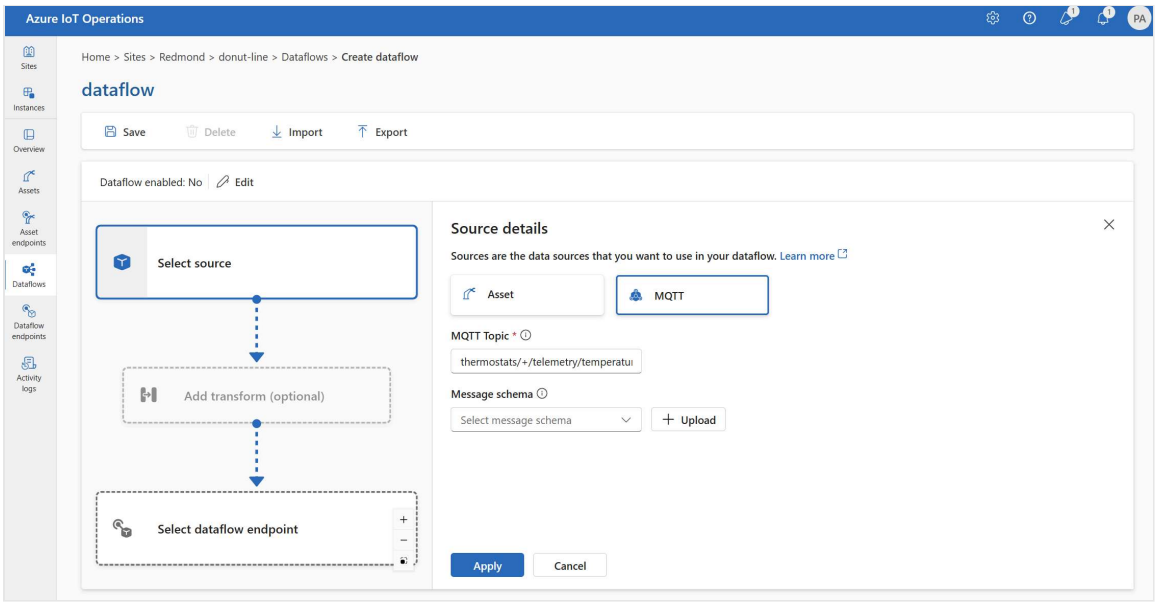
To configure a source for the dataflow, specify the endpoint reference and a list of data sources for the endpoint. Choose one of the following options as the source for the dataflow.

If the default endpoint isn't used as the source, it must be used as the destination. To learn more about, see Dataflows must use local MQTT broker endpoint.

Option 1: Use default MQTT endpoint as source

Portal

1. Under **Source details**, select **MQTT**.



2. Enter the following settings for the MQTT source:

Expand table

Setting	Description
MQTT topic	The MQTT topic filter to subscribe to for incoming messages. See Configure MQTT or Kafka topics.
Message schema	The schema to use to deserialize the incoming messages. See Specify schema to deserialize data.

3. Select **Apply**.

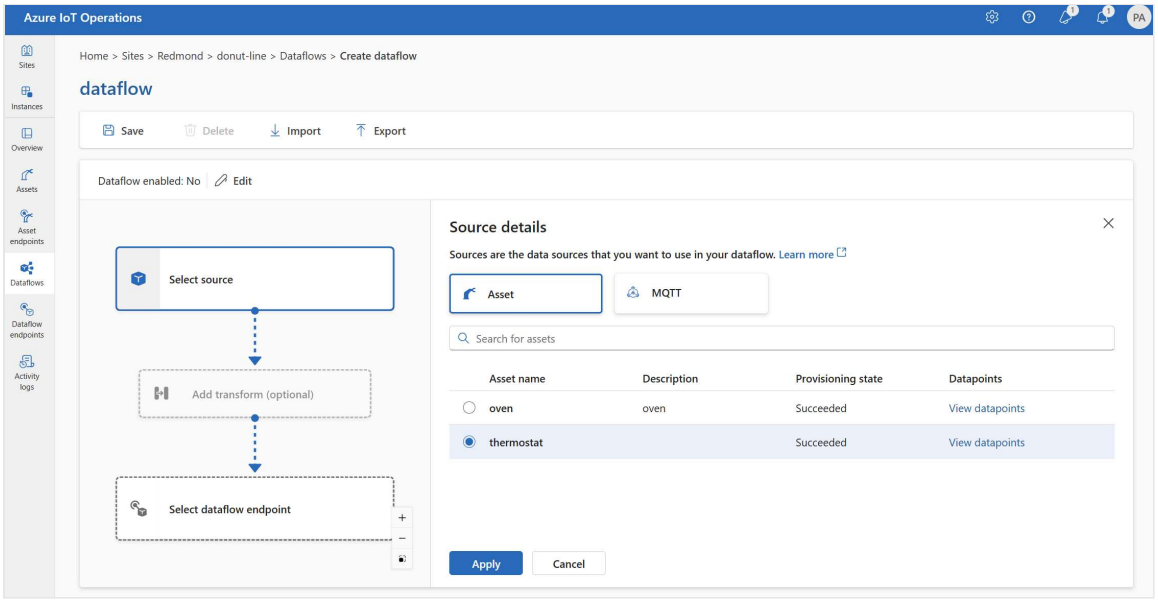
Option 2: Use asset as source

Portal

You can use an asset as the source for the dataflow. Using an asset as a source is only available in the operations experience.

1. Under **Source details**, select **Asset**.
2. Select the asset you want to use as the source endpoint.
3. Select **Proceed**.

A list of datapoints for the selected asset is displayed.



4. Select **Apply** to use the asset as the source endpoint.

When using an asset as the source, the asset definition is used to infer the schema for the dataflow. The asset definition includes the schema for the asset's datapoints. To learn more, see Manage asset configurations remotely.

Once configured, the data from the asset reached the dataflow via the local MQTT broker. So, when using an asset as the source, the dataflow uses the local MQTT broker default endpoint as the source in actuality.

Option 3: Use custom MQTT or Kafka dataflow endpoint as source

If you created a custom MQTT or Kafka dataflow endpoint (for example, to use with Event Grid or Event Hubs), you can use it as the source for the dataflow. Remember that storage type endpoints, like Data Lake or Fabric OneLake, can't be used as source.

To configure, use Kubernetes YAML or Bicep. Replace placeholder values with your custom endpoint name and topics.

Portal

Using a custom MQTT or Kafka endpoint as a source is currently not supported in the operations experience.

Configure data sources (MQTT or Kafka topics)

You can specify multiple MQTT or Kafka topics in a source without needing to modify the dataflow endpoint configuration. This flexibility means the same endpoint can be reused across multiple dataflows, even if the topics vary. For more information, see Reuse dataflow endpoints.

MQTT topics

When the source is an MQTT (Event Grid included) endpoint, you can use the MQTT topic filter to subscribe to incoming messages. The topic filter can include wildcards to subscribe to multiple topics. For example, `thermostats/+/telemetry/temperature/#` subscribes to all temperature telemetry messages from thermostats. To configure the MQTT topic filters:

Portal

In the operations experience dataflow **Source details**, select **MQTT**, then use the **MQTT topic** field to specify the MQTT topic filter to subscribe to for incoming messages.

> **Note**
>
> Only one MQTT topic filter can be specified in the operations experience. To use multiple MQTT topic filters, use Bicep or Kubernetes.

Shared subscriptions

To use shared subscriptions with MQTT sources, you can specify the shared subscription topic in the form of `$shared/<GROUP_NAME>/<TOPIC_FILTER>`.

Portal

In operations experience dataflow **Source details**, select **MQTT** and use the **MQTT topic** field to specify the shared subscription group and topic.

If the instance count in the dataflow profile is greater than one, shared subscription is automatically enabled for all dataflows that use MQTT source. In this case, the `$shared` prefix is added and the shared subscription group name automatically generated. For example, if you have a dataflow profile with an instance count of 3, and your dataflow uses an MQTT endpoint as source configured with topics `topic1` and `topic2`, they are automatically converted to shared subscriptions as `$shared/<GENERATED_GROUP_NAME>/topic1` and `$shared/<GENERATED_GROUP_NAME>/topic2`.

You can explicitly create a topic named `$shared/mygroup/topic` in your configuration. However, adding the `$shared` topic explicitly isn't recommended since the `$shared` prefix is automatically added when needed. Dataflows can make optimizations with the group name if it isn't set. For example, `$share` isn't set and dataflows only has to operate over the topic name.

Important

Dataflows requiring shared subscription when instance count is greater than one is important when using Event Grid MQTT broker as a source since it **doesn't support shared subscriptions**. To avoid missing messages, set the dataflow profile instance count to one when using Event Grid MQTT broker as the source. That is when the dataflow is the subscriber and receiving messages from the cloud.

Kafka topics

When the source is a Kafka (Event Hubs included) endpoint, specify the individual Kafka topics to subscribe to for incoming messages. Wildcards are not supported, so you must specify each topic statically.

Note

When using Event Hubs via the Kafka endpoint, each individual event hub within the namespace is the Kafka topic. For example, if you have an Event Hubs namespace with

two event hubs, `thermostats` and `humidifiers`, you can specify each event hub as a Kafka topic.

To configure the Kafka topics:

Portal

Using a Kafka endpoint as a source is currently not supported in the operations experience.

Specify source schema

When using MQTT or Kafka as the source, you can specify a schema to display the list of data points in the operations experience portal. Note that using a schema to deserialize and validate incoming messages isn't currently supported.

If the source is an asset, the schema is automatically inferred from the asset definition.

Tip

To generate the schema from a sample data file, use the **Schema Gen Helper** .

To configure the schema used to deserialize the incoming messages from a source:

Portal

In operations experience dataflow **Source details**, select **MQTT** and use the **Message schema** field to specify the schema. You can use the **Upload** button to upload a schema file first. To learn more, see Understand message schemas.

To learn more, see Understand message schemas.

Transformation

The transformation operation is where you can transform the data from the source before you send it to the destination. Transformations are optional. If you don't need to make changes to the data, don't include the transformation operation in the dataflow

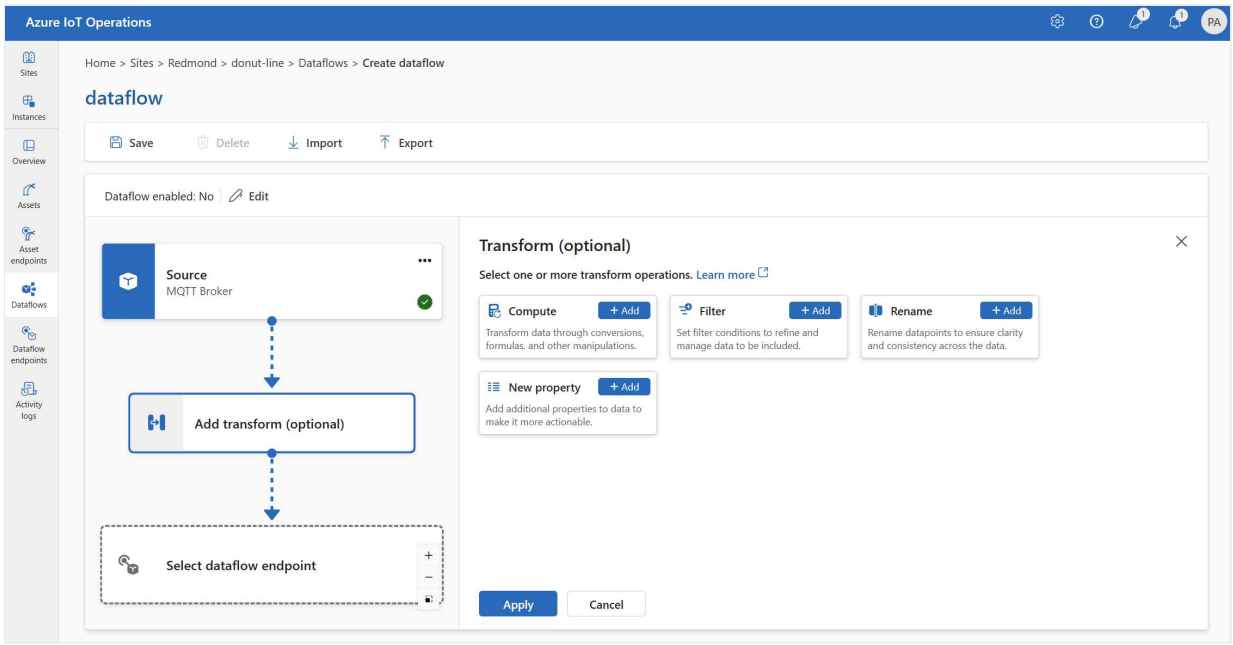
configuration. Multiple transformations are chained together in stages regardless of the order in which they're specified in the configuration. The order of the stages is always:

1. **Enrich**: Add additional data to the source data given a dataset and condition to match.
2. **Filter**: Filter the data based on a condition.
3. **Map**, **Compute**, **Rename**, or add a **New property**: Move data from one field to another with an optional conversion.

This section is an introduction to dataflow transforms. For more detailed information, see Map data by using dataflows, Convert data by using dataflow conversions, and Enrich data by using dataflows.

Portal

In the operations experience, select **Dataflow** > **Add transform (optional)**.



Enrich: Add reference data

To enrich the data, first add reference dataset in the Azure IoT Operations state store. The dataset is used to add extra data to the source data based on a condition. The condition is specified as a field in the source data that matches a field in the dataset.

You can load sample data into the state store by using the state store CLI . Key names in the state store correspond to a dataset in the dataflow configuration.

Portal

Currently, the *Enrich* stage isn't supported in the operations experience.

If the dataset has a record with the `asset` field, similar to:

JSON

```
{
  "asset": "thermostat1",
  "location": "room1",
  "manufacturer": "Contoso"
}
```

The data from the source with the `deviceId` field matching `thermostat1` has the `location` and `manufacturer` fields available in filter and map stages.

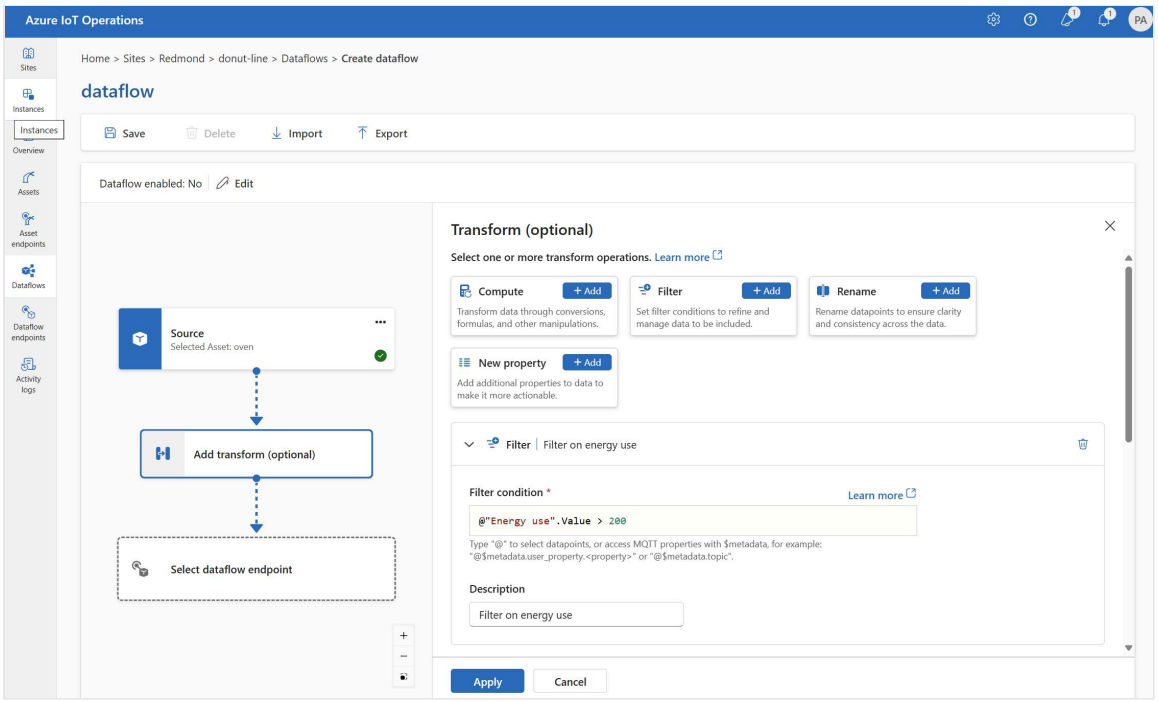
For more information about condition syntax, see Enrich data by using dataflows and Convert data using dataflows.

Filter: Filter data based on a condition

To filter the data on a condition, you can use the `filter` stage. The condition is specified as a field in the source data that matches a value.

Portal

1. Under **Transform (optional)**, select **Filter** > **Add**.



2. Enter the required settings.

Expand table

Setting	Description
Filter condition	The condition to filter the data based on a field in the source data.
Description	Provide a description for the filter condition.

In the filter condition field, enter `@` or select **Ctrl** + **Space** to choose datapoints from a dropdown.

You can enter MQTT metadata properties using the format `@$metadata.user_properties.<property>` or `@$metadata.topic`. You can also enter $metadata headers using the format `@$metadata.<header>`. The `$metadata` syntax is only needed for MQTT properties that are part of the message header. For more information, see field references.

The condition can use the fields in the source data. For example, you could use a filter condition like `@temperature > 20` to filter data less than or equal to 20 based on the temperature field.

3. Select **Apply**.

Map: Move data from one field to another

To map the data to another field with optional conversion, you can use the `map` operation. The conversion is specified as a formula that uses the fields in the source data.

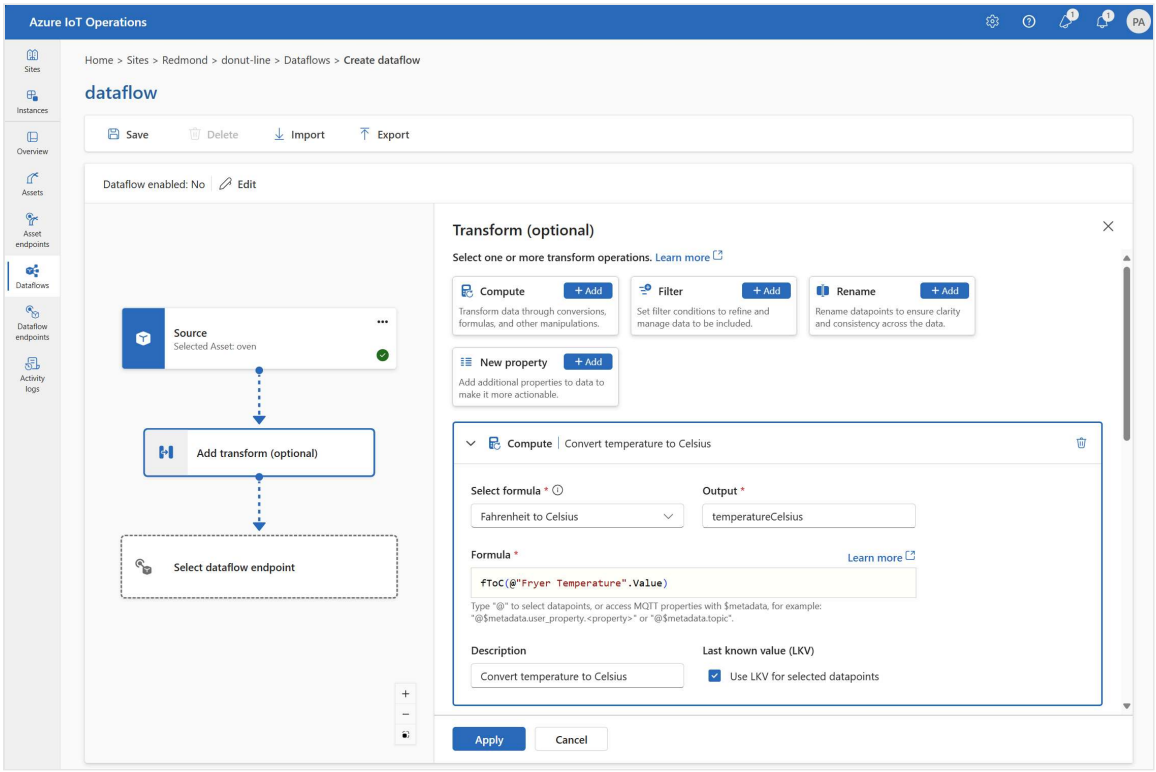
Portal

In the operations experience, mapping is currently supported using **Compute**, **Rename**, and **New property** transforms.

Compute

You can use the **Compute** transform to apply a formula to the source data. This operation is used to apply a formula to the source data and store the result field.

1. Under **Transform (optional)**, select **Compute** > **Add**.



2. Enter the required settings.

Expand table

Setting	Description
Select formula	Choose an existing formula from the dropdown or select **Custom** to enter a formula manually.
Output	Specify the output display name for the result.
Formula	Enter the formula to be applied to the source data.
Description	Provide a description for the transformation.
Last known value	Optionally, use the last known value if the current value isn't available.

You can enter or edit a formula in the **Formula** field. The formula can use the fields in the source data. Enter `@` or select **Ctrl** + **Space** to choose datapoints from a dropdown.

You can enter MQTT metadata properties using the format `@$metadata.user_properties.<property>` or `@$metadata.topic`. You can also enter $metadata headers using the format `@$metadata.<header>`. The `$metadata` syntax is only needed for MQTT properties that are part of the message header. For more information, see field references.

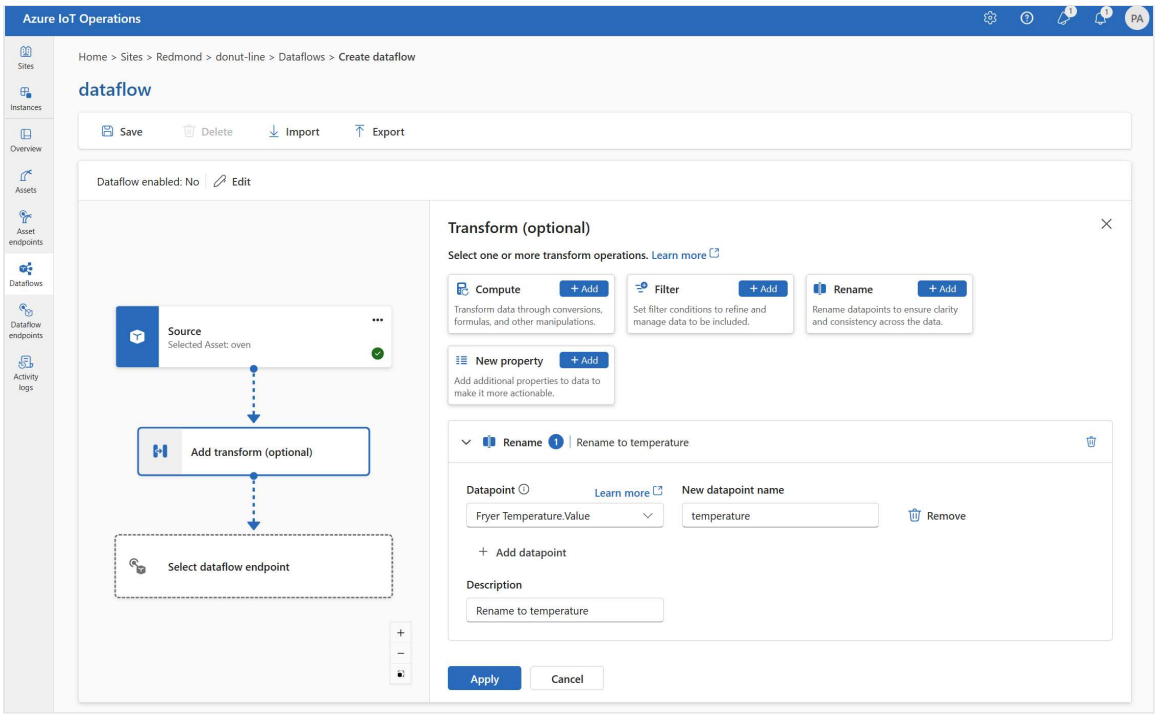
The formula can use the fields in the source data. For example, you could use the `temperature` field in the source data to convert the temperature to Celsius and store it in the `temperatureCelsius` output field.

3. Select **Apply**.

Rename

You can rename a datapoint using the **Rename** transform. This operation is used to rename a datapoint in the source data to a new name. The new name can be used in the subsequent stages of the dataflow.

1. Under **Transform (optional)**, select **Rename** > **Add**.



2. Enter the required settings.

Expand table

Setting	Description
Datapoint	Select a datapoint from the dropdown or enter a $metadata header.
New datapoint name	Enter the new name for the datapoint.
Description	Provide a description for the transformation.

Enter `@` or select **Ctrl** + **Space** to choose datapoints from a dropdown.

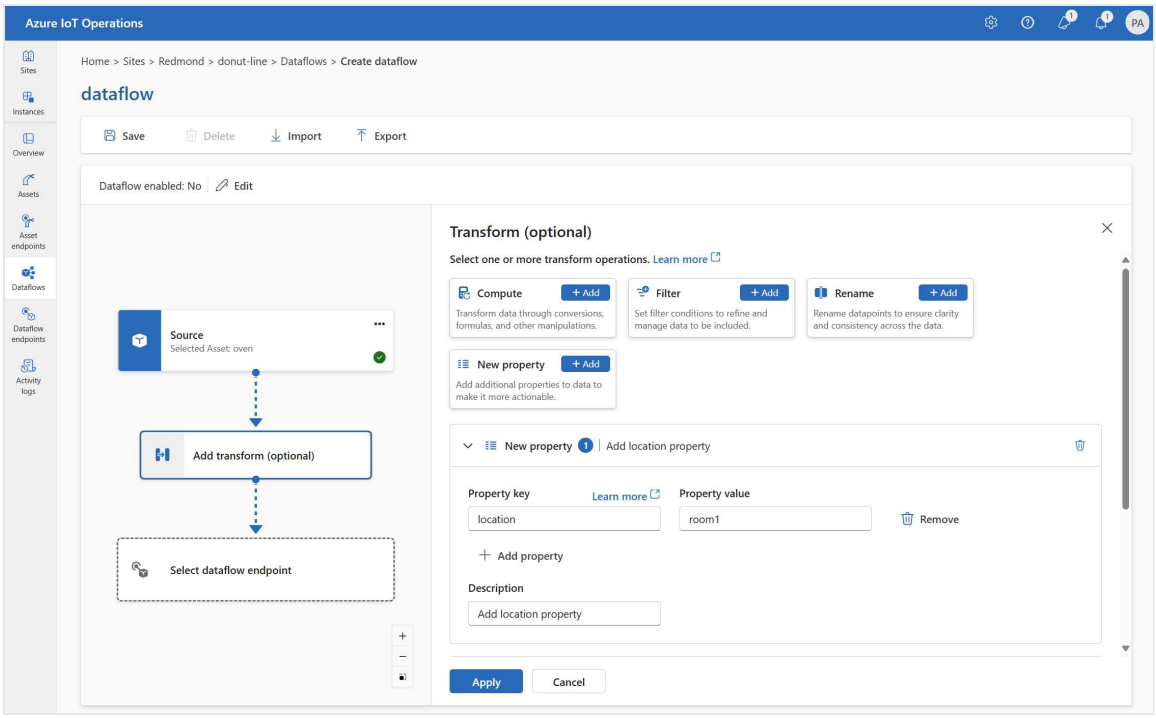
You can enter MQTT metadata properties using the format `@$metadata.user_properties.<property>` or `@$metadata.topic`. You can also enter $metadata headers using the format `@$metadata.<header>`. The `$metadata` syntax is only needed for MQTT properties that are part of the message header. For more information, see field references.

3. Select **Apply**.

New property

You can add a new property to the source data using the **New property** transform. This operation is used to add a new property to the source data. The new property can be used in the subsequent stages of the dataflow.

1. Under **Transform (optional)**, select **New property** > **Add**.



2. Enter the required settings.

Expand table

Setting	Description
Property key	Enter the key for the new property.
Property value	Enter the value for the new property.
Description	Provide a description for the new property.

3. Select **Apply**.

To learn more, see Map data by using dataflows and Convert data by using dataflows.

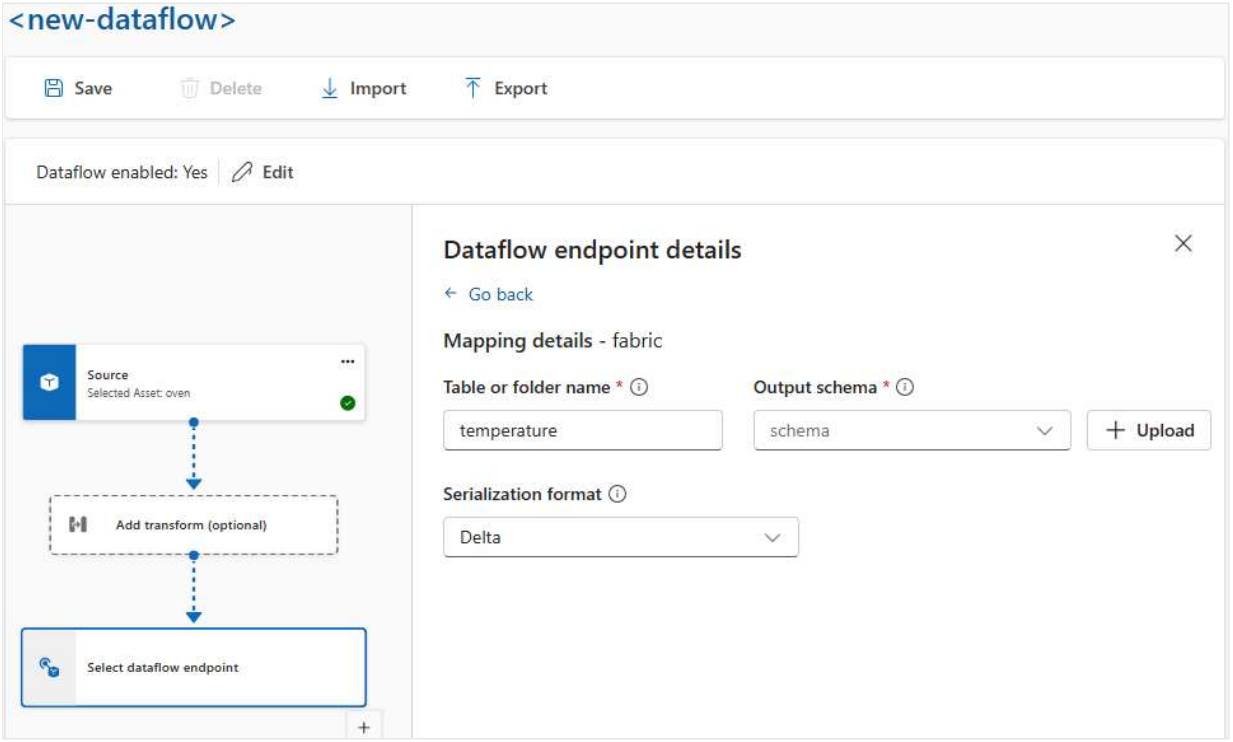
Serialize data according to a schema

If you want to serialize the data before sending it to the destination, you need to specify a schema and serialization format. Otherwise, the data is serialized in JSON with the types inferred. Storage endpoints like Microsoft Fabric or Azure Data Lake require a schema to ensure data consistency. Supported serialization formats are Parquet and Delta.

> **Tip**
>
> To generate the schema from a sample data file, use the Schema Gen Helper .

Portal

For operations experience, you specify the schema and serialization format in the dataflow endpoint details. The endpoints that support serialization formats are Microsoft Fabric OneLake, Azure Data Lake Storage Gen 2, and Azure Data Explorer. For example, to serialize the data in Delta format, you need to upload a schema to the schema registry and reference it in the dataflow destination endpoint configuration.



For more information about schema registry, see Understand message schemas.

Destination

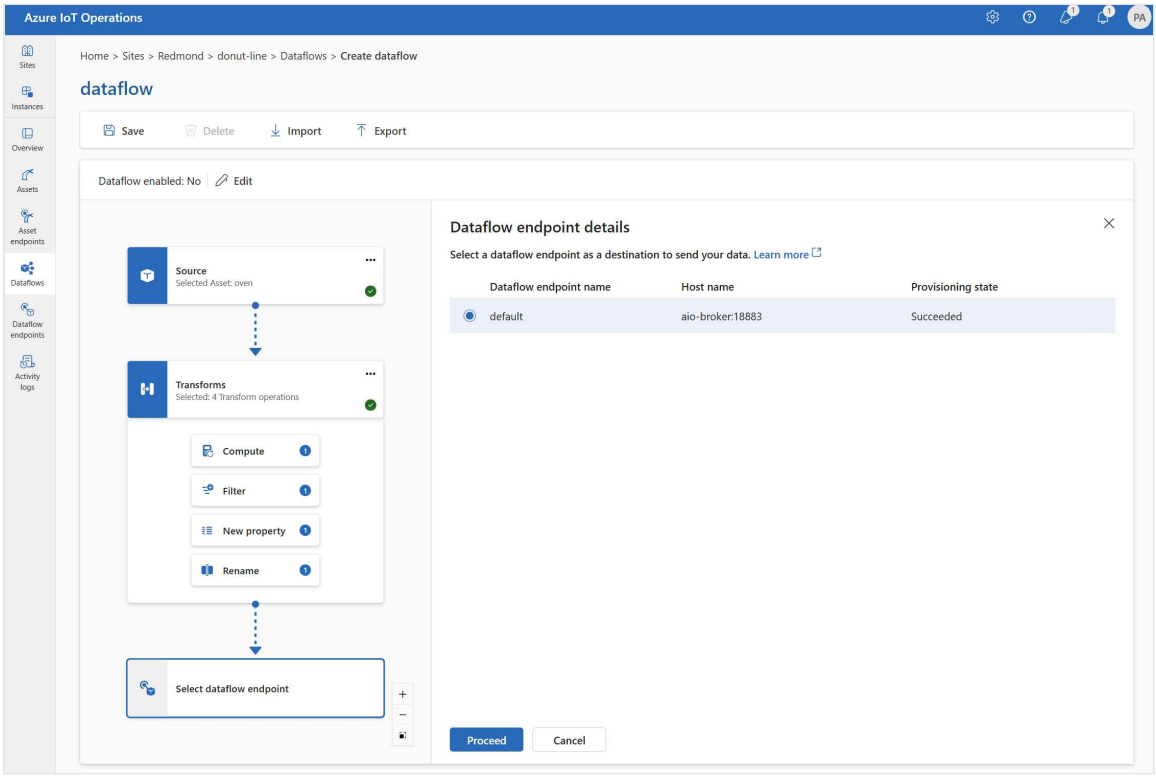
To configure a destination for the dataflow, specify the endpoint reference and data destination. You can specify a list of data destinations for the endpoint.

To send data to a destination other than the local MQTT broker, create a dataflow endpoint. To learn how, see Configure dataflow endpoints. If the destination isn't the local MQTT broker, it must be used as a source. To learn more about, see Dataflows must use local MQTT broker endpoint.

> **Important**
>
> Storage endpoints require a schema for serialization. To use dataflow with Microsoft Fabric OneLake, Azure Data Lake Storage, Azure Data Explorer, or Local Storage, you must specify a schema reference.

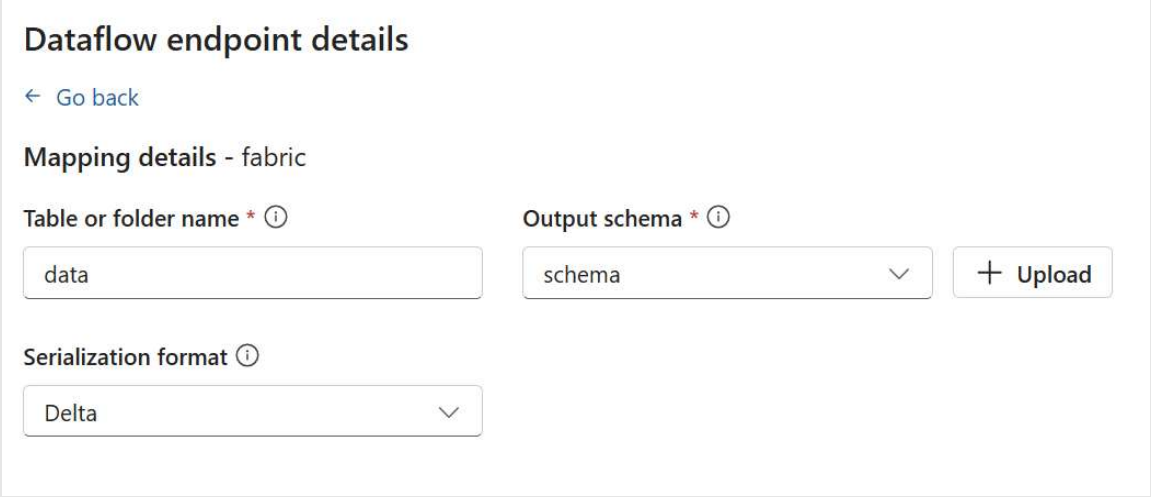
Portal

1. Select the dataflow endpoint to use as the destination.



Storage endpoints require a schema for serialization. If you choose a Microsoft Fabric OneLake, Azure Data Lake Storage, Azure Data Explorer, or Local Storage destination endpoint, you must specify a schema reference. For example, to serialize the data to a Microsoft Fabric endpoint in Delta format, you need to

upload a schema to the schema registry and reference it in the dataflow destination endpoint configuration.



2. Select **Proceed** to configure the destination.

3. Enter the required settings for the destination, including the topic or table to send the data to. See Configure data destination (topic, container, or table) for more information.

Configure data destination (topic, container, or table)

Similar to data sources, data destination is a concept that is used to keep the dataflow endpoints reusable across multiple dataflows. Essentially, it represents the subdirectory in the dataflow endpoint configuration. For example, if the dataflow endpoint is a storage endpoint, the data destination is the table in the storage account. If the dataflow endpoint is a Kafka endpoint, the data destination is the Kafka topic.

Expand table

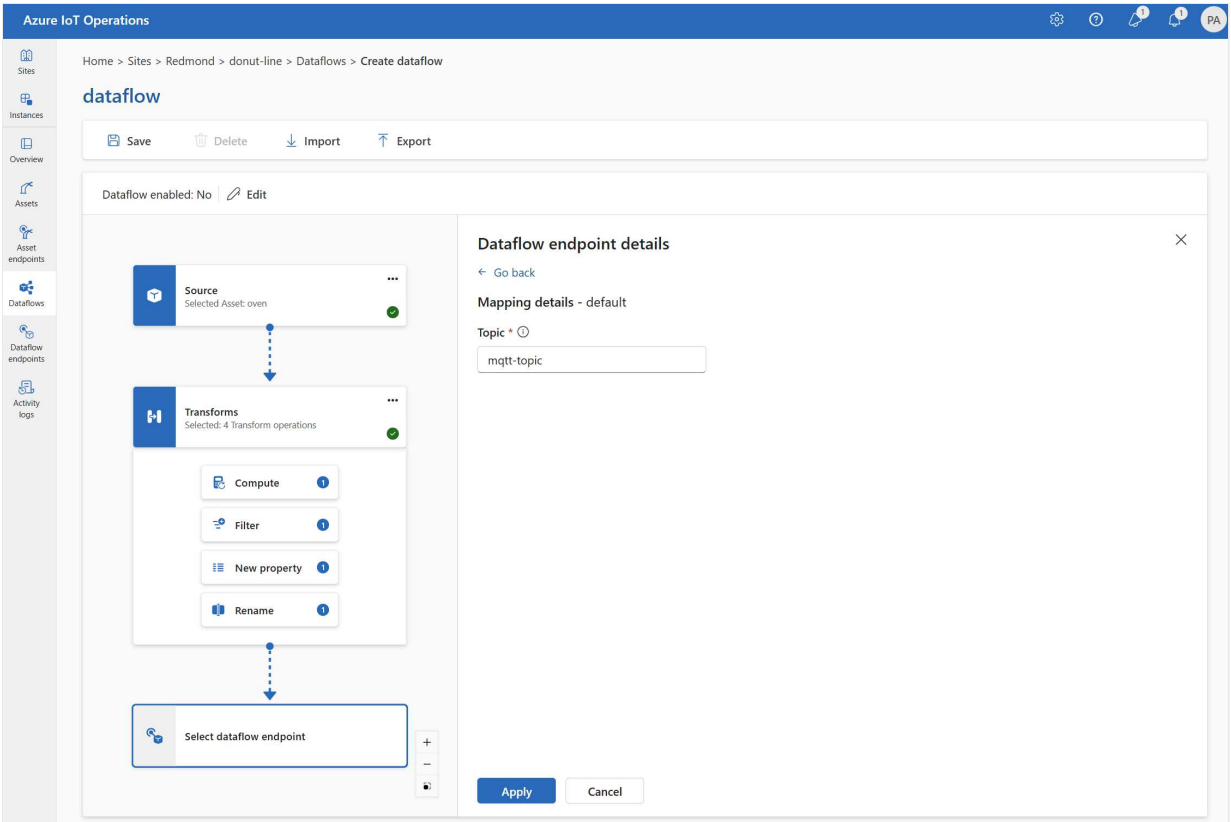
Endpoint type	Data destination meaning	Description
MQTT (or Event Grid)	Topic	The MQTT topic where the data is sent. Only static topics are supported, no wildcards.
Kafka (or Event Hubs)	Topic	The Kafka topic where the data is sent. Only static topics are supported, no wildcards. If the endpoint is an Event Hubs

Endpoint type	Data destination meaning	Description
		namespace, the data destination is the individual event hub within the namespace.
Azure Data Lake Storage	Container	The container in the storage account. Not the table.
Microsoft Fabric OneLake	Table or Folder	Corresponds to the configured path type for the endpoint.
Azure Data Explorer	Table	The table in the Azure Data Explorer database.
Local Storage	Folder	The folder or directory name in the local storage persistent volume mount. When using Azure Container Storage enabled by Azure Arc Cloud Ingest Edge Volumes, this must match the `spec.path` parameter for the subvolume you created.

To configure the data destination:

Portal

When using the operations experience, the data destination field is automatically interpreted based on the endpoint type. For example, if the dataflow endpoint is a storage endpoint, the destination details page prompts you to enter the container name. If the dataflow endpoint is an MQTT endpoint, the destination details page prompts you to enter the topic, and so on.



Example

The following example is a dataflow configuration that uses the MQTT endpoint for the source and destination. The source filters the data from the MQTT topic `azure-iot-operations/data/thermostat`. The transformation converts the temperature to Fahrenheit and filters the data where the temperature multiplied by the humidity is less than 100000. The destination sends the data to the MQTT topic `factory`.

Portal

See Bicep or Kubernetes tabs for the configuration example.

To see more examples of dataflow configurations, see Azure REST API - Dataflow and the quickstart Bicep .

Verify a dataflow is working

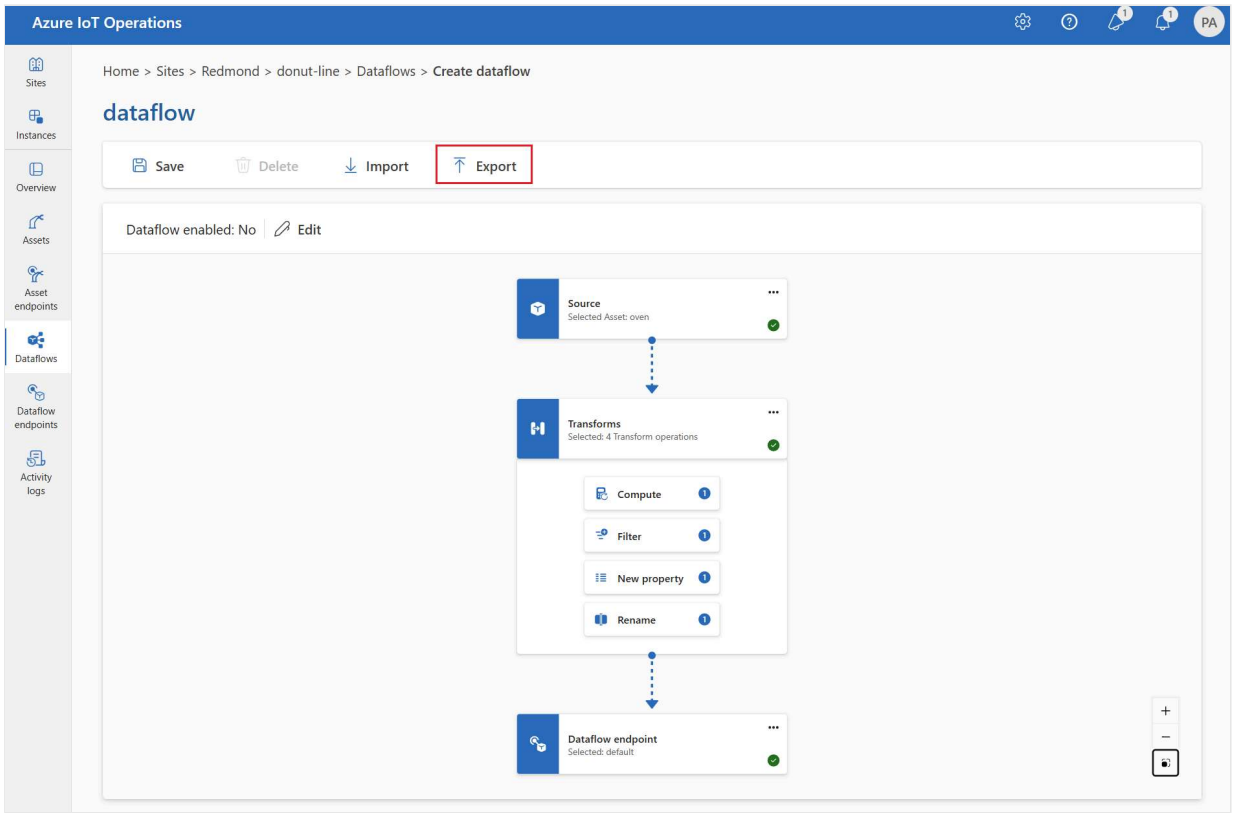
Follow Tutorial: Bi-directional MQTT bridge to Azure Event Grid to verify the dataflow is working.

Export dataflow configuration

To export the dataflow configuration, you can use the operations experience or by exporting the Dataflow custom resource.

Portal

Select the dataflow you want to export and select **Export** from the toolbar.



Proper dataflow configuration

To ensure the dataflow is working as expected, verify the following:

- The default MQTT dataflow endpoint must be used as either the source or destination.
- The dataflow profile exists and is referenced in the dataflow configuration.
- Source is either an MQTT endpoint, Kafka endpoint, or an asset. Storage type endpoints can't be used as a source.
- When using Event Grid as the source, the dataflow profile instance count is set to 1 because Event Grid MQTT broker doesn't support shared subscriptions.

- When using Event Hubs as the source, each event hub in the namespace is a separate Kafka topic and must be specified as the data source.
- Transformation, if used, is configured with proper syntax, including proper escaping of special characters.
- When using storage type endpoints as destination, a schema is specified.

Next steps

- Map data by using dataflows
- Convert data by using dataflows
- Enrich data by using dataflows
- Understand message schemas
- Manage dataflow profiles

ⓘ **Note:** The author created this article with assistance from AI. Learn more

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