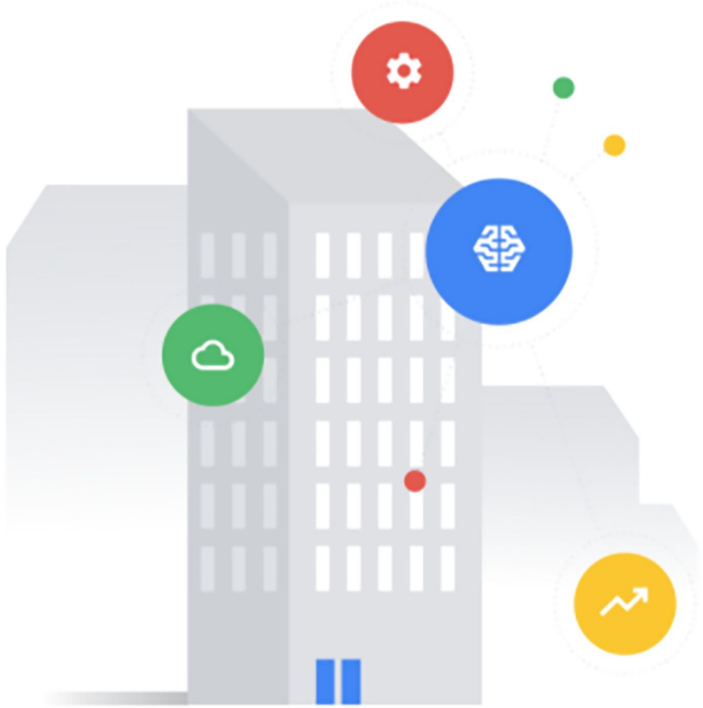
Google

Module 1 | **Lesson 3**

Digital Buildings Ontology (DBO)



Before you get started

This learning module has interactive features and activities that enable a self-guided learning experience. To help you get started, here are two tips for viewing and navigating through the content.

1 View this content outside of GitHub.

- For the best learning experience, you're encouraged to download a copy so links and other interactive features will be enabled.
- To download a copy of this lesson, click **Download** in the top-right corner of this content block.
- After downloading, open the file in your preferred PDF reader application.

2 Navigate by clicking the buttons and links.

- For the best learning experience, using your keyboard or mouse wheel to navigate is discouraged. However, this is your only option if you're viewing from GitHub.
- If you're viewing this content outside of GitHub:
  - Click the **Back** or **Next** buttons to go backward or forward in the deck. Moving forward, you'll find them in the bottom corners of every slide.
  - Click blue text to go to another slide in this deck or open a new page in your browser.

Ready to get started? Let's go!

Google

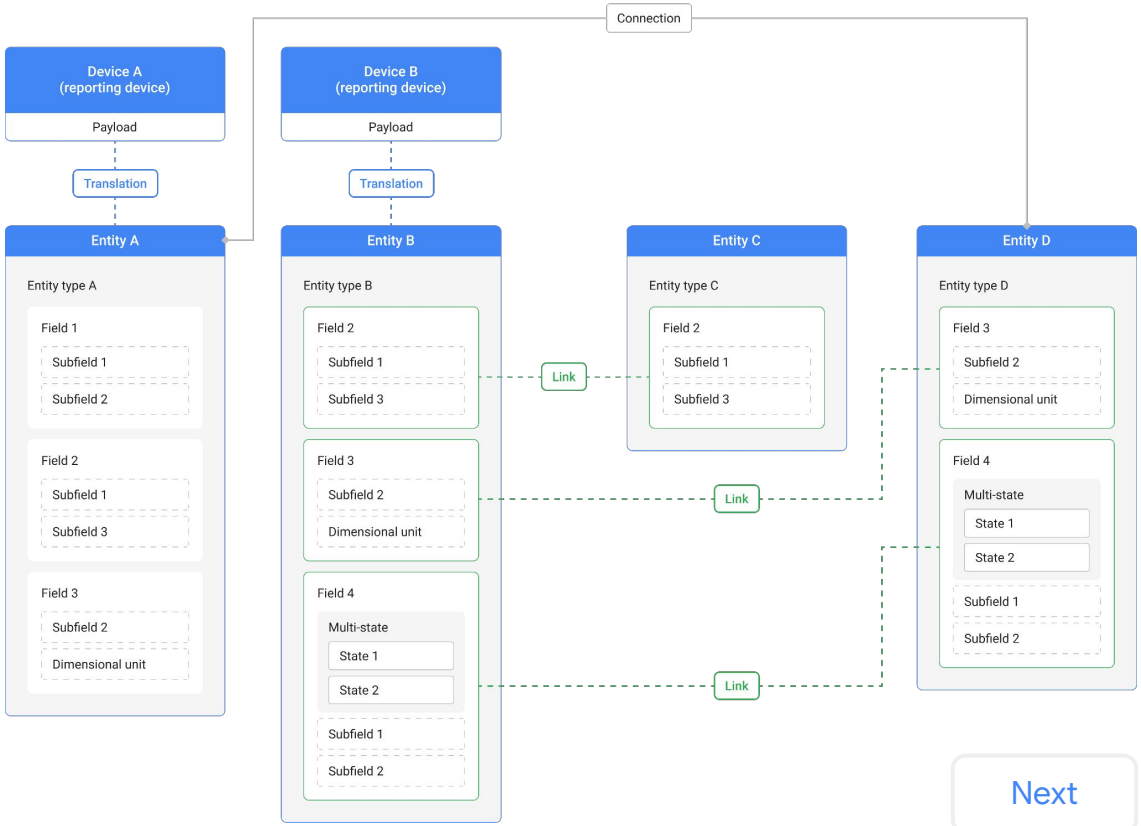
Conceptual model revisited

Here's another look at the DBO conceptual model from Lesson 2.

In this lesson, you'll explore one modeling concept from the abstract model. Remember, abstract modeling concepts are used to describe the properties of an entity. Abstract concepts include:

- Subfields
- Fields
- States and multi-states
- Entity types

Do you see these concepts in the diagram?



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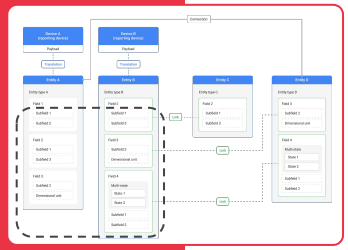
Lesson 3

Subfields



What you'll learn about:

- Subfields
- Subfield constraints
- Subfield categories
- Dimensional units of measurement
- Point types

By the end of this lesson, you'll be able to:

- Describe the concept of a subfield.
- Identify a subfield in source code.
- Understand the rules and constraints for a subfield.
- Recognize the use cases for seven subfield categories.
- Recognize when dimensional units apply.
- Understand point types designate different types of data.

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What's a subfield?

A subfield is the basic unit of meaning in the DBO.

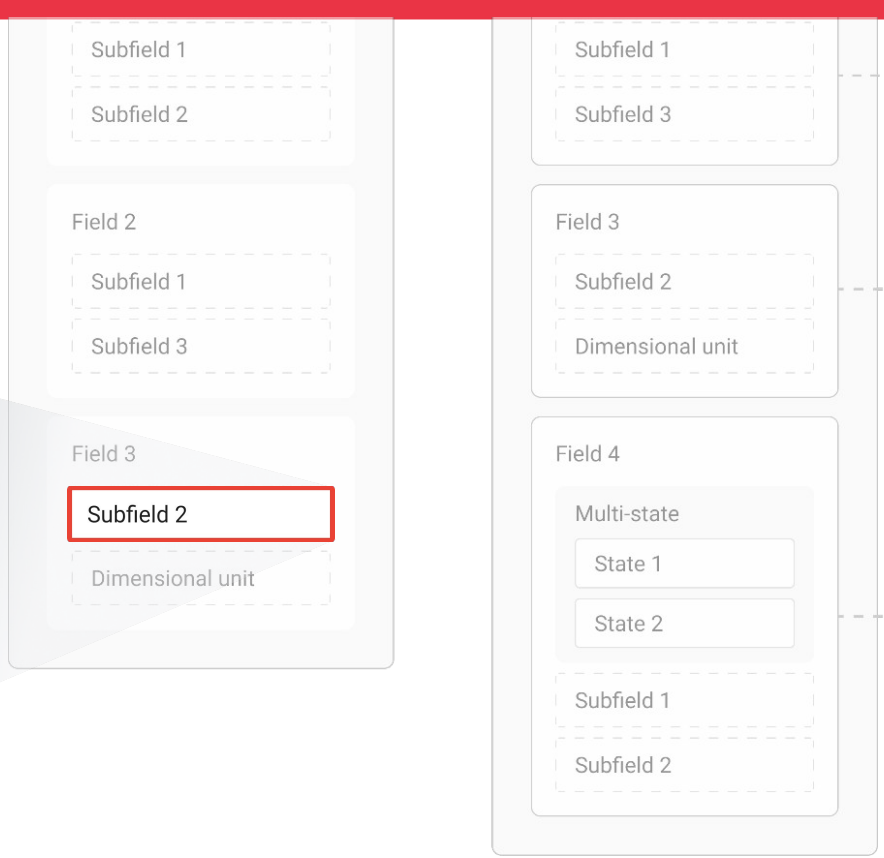
Each subfield consists of a single or compounded word with a specific, human-readable definition.

Examples

detection: "Process of identifying conditions."

discharge: "Media leaving system to enter ambient conditioned space. Typically applies only to air-side systems."

east: "Cardinal direction; opposite of west"



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Subfield constraints

Remember the following constraints when working with subfields.

Subfields should always:

- Be uniquely named in their namespace.
- Have a unique, specific, and well-defined meaning.
- Be used universally across different namespaces and applications.
- Be organized into categories based on purpose.
- Be used to construct fields.

Subfields should normally:

- Be globally defined.
- Be single words.

Subfields should rarely:

- Be compound words.
- Be domain-specific jargon.
- Be an acronym for something else (e.g., `VFD` would generally not be allowed).

Note: Under certain circumstances this does happen, but it should be as infrequent as is practical.

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Note: You'll learn about fields in Lesson 4 and namespaces in Lesson 9 of this module.

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Subfield categories

Subfields are organized into seven different categories based on purpose.

Click on each category to reveal information, examples, and use cases.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
  - Dimensional units
- Point type
  - Types of data

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Subfield categories

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`(<Agg_Desc>_)?`

Aggregation Descriptor

The aggregation descriptor subfield augments time-related aggregations. Without this subfield, an aggregation is assumed to be spatial.

This is an optional subfield that can only be used once and only in conjunction with an aggregation.

Use case

A power meter sends the maximum daily power use observed over that window (fixed).

Examples

`daily:` `"Daily aggregation; fixed window assumed"`

`fivesecond:` `"Window of 5 seconds; fixed window assumed."`

`fivesecondrolling:` `"Window of 5 seconds; uses a rolling window."`

All curated aggregation descriptors will be added to subfields.yaml in the Digital Buildings Project GitHub repo.

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Note: The **`max`** and **`min`** aggregators are not the same as an operating limit, such as the high and low limits for a supply temperature setpoint reset.

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Subfield categories

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- Aggregation descriptor
- **Aggregation**
- Descriptor
- Component
- Measurement descriptor
- Measurement
  - Dimensional units
- Point type
  - Types of data

(<Agg>_)?

Aggregation

The aggregation subfield is an aggregator of values. Unless it's augmented by an aggregation descriptor, the aggregation subfield is always assumed to be spatial values.

This is an optional subfield that can only be used once per field.

Use case

A space has multiple temperature sensors, and each sensor provides different values. An aggregation subfield would be used to specify the current reading is an aggregation of multiple independent readings (i.e., spatially independent).

Examples

```
average: "Average value (e.g. average_zone_air_temperature_sensor)"
max: "Maximum value (e.g. Max_Cooling_Air_Flow_Setpoint)"
min: "Minimum value (e.g. Min_Ventilation_Air_Flow_Setpoint)"
```

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available aggregators.

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Note: The `max` and `min` aggregators are not the same as an operating limit, such as the high and low limits for a supply temperature setpoint reset.

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Subfield categories

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- **Descriptor**
- Component
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  - Types of data

`(<descr>_)*`

Descriptor

The descriptor subfield is a general purpose modifier that specifies the exact function of the field within the context of the entity.

This is an optional subfield that can be used multiple times per field.

Use case

A VAV may have a discharge sensor and a zone temperature sensor. Both sensors measure the same attribute, but they're located in different physical locations in the system. Descriptor subfields would be used to distinguish between the two sensors in the VAV.

Examples

```
discharge: "Media leaving system to enter ambient conditioned space. Typically applies only to air-side systems."

return: "Measurement or process of media as it is returned from the end-use equipment within the system."

zone: "Region of building which is conditioned."
```

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available descriptors.

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Note: When constructing a field, only use the minimum number of descriptors for the field to be clearly understandable and unique within the device. Extraneous descriptors should be omitted.

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Subfield categories

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- Aggregation
- Descriptor
- **Component**
- Measurement descriptor
- Measurement
  - Dimensional units
- Point type
  - Types of data

`(<component>_)?`

Component

The component subfield is an identifier for the specific subcomponent of the entity. It's useful for entities that have several physical subcomponents with similar operation.

This is an optional subfield that can only be used once per field.

Use case

An AHU may have a supply fan and an exhaust fan. A component subfield would be used to represent each fan.

Examples

damper: "Component which meters the flow of air within a system or device."

fan: "Component used for the distribution of air."

valve: "Component which meters the flow of water within a system or device."

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available components.

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Subfield categories

Subfields are organized into seven different categories based on purpose.

Click on each category to reveal information, examples, and use cases.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- **Measurement descriptor**
- Measurement
  - Dimensional units
- Point type
  - Types of data

`(<meas. descr>_)?`

Measurement descriptor

The measurement descriptor subfield modifies the measurement subfield with additional context.

This is an optional subfield that can only be used once per field.

Use case

Pressure is often measured one of two ways:

- Differential or “gage” pressure (i.e., across a pipe header or with respect to atmosphere)
- Absolute pressure (i.e., with respect to a vacuum)

A measurement descriptor subfield would be used to distinguish between differential and absolute pressure.

Examples

`differential`: "Measured difference between two reference points (e.g. differential_water_pressure)"

`relative`: "Quality of media with respect to theoretical minimum or maximum value for a given condition (e.g. relative humidity)."

`static`: "Resting or stagnant value (e.g. static_pressure_sensor)."

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available measurement descriptors.

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Subfield categories

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- Measurement descriptor
- **Measurement**
  - Dimensional units
- Point type
  - Types of data

`(<meas>_)?`

Measurement

The measurement subfield is an identifier for the type of measurement being performed.

This is a required subfield for numeric values unless the point type subfield is **`count`** or **`counter`**. It can only be used once per field.

Use case

A supply air duct has multiple sensors that perform different measurements. A measurement subfield would be used to distinguish between its temperature sensor and pressure sensor.

Examples

`flowrate`: "Rate of fluid movement."

`temperature`: "Measures the temperature of media within a process or system."

`volume`: "The quantity of three-dimensional space contained by a closed surface."

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available measurements.

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Note: Measurements are exclusive to a particular physical quantity, but they may have different units of measurement. The next slide includes more info about dimensional units.

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Subfield categories

Subfields are organized into seven different categories based on purpose.

Click on each category to reveal information, examples, and use cases.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
  - **Dimensional units**
- Point type
  - Types of data

Dimensional units

A **dimensional unit** is the standard unit and all supported units of measurement for an analog field. The measurement subfield identifies the dimensional unit.

Quantity kinds

The measurement subfield is associated with one and only one kind of quantity, which restricts the dimensional units that can be used.

Standardization

To ease standardization, standard units should be from the same unit family. The DBO standardizes on SI (i.e., the metric system) as the unit family.

Conversion factors

The DBO doesn't explicitly call out conversion factors. However, we generally conform to unit names from QUDT so their conversion factors can be used.

Examples

Here's a field that uses **`temperature`** as a measurement subfield.

```
zone_air_temperature_sensor
```

Since **`temperature`** is applied to the measurement subfield:

- Celsius can be assigned as the standard unit.
- Celsius, Fahrenheit, Kelvin, and Rankine are all supported units.
- It can only be associated with units like Kelvin or Fahrenheit.
- It can't be associated with pounds, because that is a different kind of quantity.

See units.yaml in the Digital Buildings Project GitHub repo for a list of all available dimensional units.

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Subfield categories

Subfields are organized into seven different categories based on purpose.

Click on each category to reveal information, examples, and use cases.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
  - Dimensional units
- **Point type**
  - Types of data

<PointType>

Point type

The point type subfield indicates a point's function across several layers of context.

This is a required subfield that can only be used once per field.

Use case

Differentiates points from each other; sensors indicate analog values and statuses indicate multi-state values.

Examples

`count`: "Total count of actions or requests."

`sensor`: "Component used to measure some quality of a system or process. Can be feedback for an analog command."

`setpoint`: "Control target of process or system."

See subfields.yaml in the Digital Buildings Project GitHub repo for a list of all available point types.

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Note: If `status` is declared in the point type subfield, then the field is expected to be a multi-state value. For example, `power_status` will be expected as a multistate; thus overriding the units requirement. This is useful when a certain sensor returns a status of its function, rather than the reading itself..

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Subfield categories

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  - Dimensional units
- Point type
  - Types of data

Types of data

The table below outlines the possible data types for each point type.

	Number	Integer	Multi-state	String	Date/Time
accumulator	✅	❌	❌	❌	❌
alarm	❌	❌	✅	❌	❌
capacity	✅	❌	❌	❌	❌
counter	❌	✅	❌	❌	❌
command	✅	❌	✅	❌	❌
count	❌	✅	❌	❌	❌
label	❌	❌	❌	✅	❌
mode	❌	❌	✅	❌	❌
requirement	✅	❌	❌	❌	❌
sensor	✅	❌	❌	❌	❌
setpoint	✅	❌	❌	❌	❌
status	❌	❌	✅	❌	❌
specification	✅	❌	❌	❌	❌
timestamp	❌	❌	❌	❌	✅

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Lesson 3

Knowledge check

Let's take a moment to reflect on what you've learned so far.

- The next slides will have questions about the concepts that were introduced in this lesson.
- Review each question and select the correct response.

If there are more than two answer options, you won't be able to move forward until the correct answer is selected.

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*Click **Next** when you're ready to begin.*

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Google

Knowledge check 1

A subfield consists of a single or compounded _____ with a specific, human-readable definition.

Fill in the blank.

Select the best answer from the options listed below.

- tag
- word
- model
- concept

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Google

Knowledge check 1

A subfield consists of a single or compounded _____ with a specific, human-readable definition.

Fill in the blank.

Select the best answer from the options listed below.

- tag
- word
- model
- concept

Hmm, that's not right! 🤔

Try again

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Knowledge check 1

A subfield consists of a single or compounded _____ with a specific, human-readable definition.

Fill in the blank.

Select the best answer from the options listed below.

tag

word

model

concept

That's right! 🎉

As the DBO's basic unit of meaning, a subfield is simply a word and its definition. Subfields normally consist of a single word and are rarely compounded. They're organized into purpose-based categories. They're used to construct fields.

Example

`discharge: "Media leaving system to enter ambient conditioned space. Typically applies only to air-side systems."`

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Next

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Knowledge check 1

A subfield consists of a single or compounded _____ with a specific, human-readable definition.

Fill in the blank.

Select the best answer from the options listed below.

tag | word

model | concept

Hmm, that's not right! 🤔

Try again

Back

Next

Knowledge check 1

A subfield consists of a single or compounded _____ with a specific, human-readable definition.

Fill in the blank.

Select the best answer from the options listed below.

tag | word

model | concept

Hmm, that's not right! 🤔

Try again

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Next

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

An **aggregation descriptor subfield** is definitely optional.

Aggregator descriptors are used to augment time-related aggregations. Not everything that's modeled will require an aggregation of values.

Try again

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Next

Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

An **aggregation subfield** is definitely optional.

Aggregators are used to aggregate values in the spatial domain. Not everything that's modeled will require aggregating values.

Try again

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **descriptor subfield** is definitely optional.

Descriptors are general purpose modifiers that specify the exact function of a field within the context of the entity. These should be used sparingly.

Try again

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **component subfield** is definitely optional.

Components identify and differentiate between the specific subcomponents of an entity, like an AHU with multiple fans. Not everything that's modeled will have subcomponents.

Try again

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **measurement descriptor subfield** is definitely optional.

Measurement descriptors simply modify the measurement subfield if additional context is needed.

Try again

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Close... but not quite right! 🤔

A **measurement subfield** is definitely optional as long as the point type subfield is `count` or `counter`. If the point type is anything else, then the measurement is actually required.

Measurements identify the type of measurement being performed, the quantity kind, and the dimensional unit.

Try again

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Knowledge check 2

Subfields are organized into seven different categories based on purpose.

Which subfield category is always required to be used to construct a field?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

That's right! 🎉

The **point type subfield** is the only subfield that is required to construct a field.

Since everything that you'll model deals with data points, it makes sense that point types are required. All other subfield categories are optional (or could be required only if certain conditions are met).

Remember, the purpose of point types is to indicate a point's function and differentiate between points and their values.

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

An **aggregation descriptor subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

An **aggregation subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **descriptor subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **component subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **measurement descriptor subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- **Measurement**
- Point type

That's right! 🎉

The **measurement subfield** identifies the dimensional unit.

Remember, dimensional units are restricted by the quantity kind of the measurement subfield (e.g., a `temperature` measurement can assign `Celsius` but cannot assign `Inch`).

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Knowledge check 3

A dimensional unit is the standard unit and all supported units of measurement for a field.

Which subfield category identifies the dimensional unit?

Select the best answer from the options listed below.

- Aggregation descriptor
- Aggregation
- Descriptor
- Component
- Measurement descriptor
- Measurement
- Point type

Hmm, that's not right! 🤔

A **point type subfield** doesn't identify the dimensional unit.

Try again

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Knowledge check 4

You see **`status`** is declared in the point type subfield.

```
dishwasher_run_status
```

What value could be returned?

Select the best answer from the options listed below.

- ON
- 72° F
- 8 in.
- 14 kW

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Knowledge check 4

You see **`status`** is declared in the point type subfield.

```
dishwasher_run_status
```

What value could be returned?

Select the best answer from the options listed below.

- ON
- 72° F
- 8 in.
- 14 kW

That's right! 🎉

Whenever the point type subfield has declared **`status`**, then the field is expected to be a multi-state value.

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Knowledge check 4

You see **`status`** is declared in the point type subfield.

```
dishwasher_run_status
```

What value could be returned?

Select the best answer from the options listed below.

- ON
- 72° F
- 8 in.
- 14 kW

Hmm, that's not right! 🤔

Remember, if **`status`** is declared in the point type subfield, then the field is expected to be a multi-state value.

Try again

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Knowledge check 4

You see **`status`** is declared in the point type subfield.

```
dishwasher_run_status
```

What value could be returned?

Select the best answer from the options listed below.

- ON
- 72° F
- 8 in.
- 14 kW

Hmm, that's not right! 🤔

Remember, if **`status`** is declared in the point type subfield, then the field is expected to be a multi-state value.

Try again

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Knowledge check 4

You see **`status`** is declared in the point type subfield.

```
dishwasher_run_status
```

What value could be returned?

Select the best answer from the options listed below.

- ON
- 72° F
- 8 in.
- 14 kW

Hmm, that's not right! 🤔

Remember, if **`status`** is declared in the point type subfield, then the field is expected to be a multi-state value.

Try again

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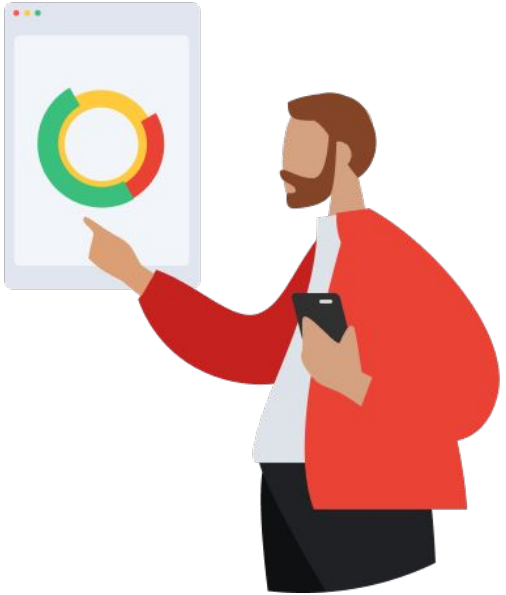
Lesson 3 summary

Let's review what you learned about:

- Subfields
- Subfield constraints
- Subfield categories
- Dimensional units of measurement
- Point types

Now you should be able to:

- Describe the concept of a subfield.
- Identify a subfield in source code.
- Understand the rules and constraints for a subfield.
- Recognize the use cases for seven subfield categories.
- Recognize when dimensional units apply.
- Understand point types designate different types of data.



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You completed Lesson 3!

Now's a great time to take a quick break before starting Lesson 4.

Ready for Lesson 4?

Let's go!

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Helpful resources

For future reference, keep these resources easily accessible for technical and procedural questions.

- digitalbuildings / ontology / yaml / resources / subfields / subfields.yaml
  Contains all of the available subfields.
- digitalbuildings / ontology
  Contains the documentation and configuration files for the DBO.
- digitalbuildings / ontology / docs / ontology.md
  Provides an overview of the structure and principles of the ontology.
- digitalbuildings / ontology / docs / model.md
  Describes the conventions used in the DBO abstract model.
- Digital Buildings Project GitHub
  Contains source code, tooling, and documentation for the DBO.