



Module 2 | Lesson 1



Data modeling with the 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!



Lesson 3

Get ready to data model

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What you'll learn about:

- “Good” building configuration files
- Greenfield and brownfield sites
- Recommended data modeling workflow
- Data modeling resources

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

- Reference “good” examples of building configuration files.
- Understand the difference between a greenfield and brownfield site.
- Recall our recommended data modeling workflow.
- Find helpful tooling, documentation, and references for data modeling with the DBO.

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Data modeling and the building configuration file

You'll use data modeling to create a **building configuration file**.

What's a building configuration file?

The **building configuration file** is a file that maps real-world devices to the Digital Building Ontology (DBO). Also known as a building config file or simply building config for short, these files are an important part of every digital building project that uses the DBO.

Building configs make a building's data useful and recognizable across any deployment. They encode all of the relevant information about a building and its installed equipment including:

- What equipment exists
- What types they apply
- Which equipment connects to other equipment
- What equipment serves which zone
- And so on

Usually, one building config file contains all the relevant info for one building. You may find you'll need multiple building configs depending on your project's requirements and specific data modeling needs, which is supported.

Example

Here's a look at what a building config file might look like.

```
1  US-MTV-1234:  
2    id: FACILITIES/buildings/36166722673234  
3    type: FACILITIES/BUILDING  
4  
5  EF - 3 Restroom / Bldg:  
6    cloud_device_id: '2804802894218214135'  
7    connections:  
8      US-MTV-SB55:  
9        - CONTAINS  
10       id: CDM/2804808941814135  
11       translation:  
12         run_command:  
13           present_value: data.binary-output_1.present-value  
14           states:  
15             'OFF': inactive  
16             'ON': active  
17       run_status:  
18         present_value: data.binary-input_1.present-value  
19         states:  
20           'OFF': inactive  
21           'ON': active  
22       type: HVAC/FAN_SS
```

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Note: You'll learn more about formatting, constructing, and finalizing building configuration files in Lesson 6 of this module. Let's stay high level for now and explore the resources and recommended workflow that will guide the data modeling process.

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Data modeling and the building config file (continued)

You'll use data modeling to create a **building configuration file**.

What's a “good” building configuration file?

A “good” building config is one that's error-free and fully conforms to the DBO. Haphazard data modeling isn't acceptable!

The Digital Building Project GitHub repository provides several samples from “good” building configs from the HVAC namespace including:

- [Air handling units \(AHU\)](#)
- [Chilled and condensing water systems \(CHWS and CWS\)](#)
- [Fan coil units \(FCU\)](#)
- [Heating water systems \(HWS\)](#)

These samples should serve as precedent in your own data modeling work.

Example

Here's a look at what a building config file might look like.

```
1  US-MTV-1234:
2    id: FACILITIES/buildings/36166722673234
3    type: FACILITIES/BUILDING
4
5  EF - 3 Restroom / Bldg:
6    cloud_device_id: '2804802894218214135'
7    connections:
8      US-MTV-SB55:
9        - CONTAINS
10       id: CDM/2804808941814135
11       translation:
12         run_command:
13           present_value: data.binary-output_1.present-value
14         states:
15           'OFF': inactive
16           'ON': active
17       run_status:
18         present_value: data.binary-input_1.present-value
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22     type: HVAC/FAN_SS
```

Note: You'll learn more about formatting, constructing, and finalizing building configuration files in Lesson 6 of this module. Let's stay high level for now and explore the resources and recommended workflow that will guide the data modeling process.

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Data modeling and the building config file (continued)

You'll use data modeling to create a **building configuration file**.

Example

Here's a sample of what you might start and end with over the course of your project.

This is an air handling unit (AHU) that serves as an individual zone as a stand-alone device.

The BMS screenshot is something you might reference to construct a building config.

In the building config sample, notice there are several DBO modeling concepts present:

- **Connections**
- **Translation mappings**
- **Entity types**
- **Fields**

BMS screenshot

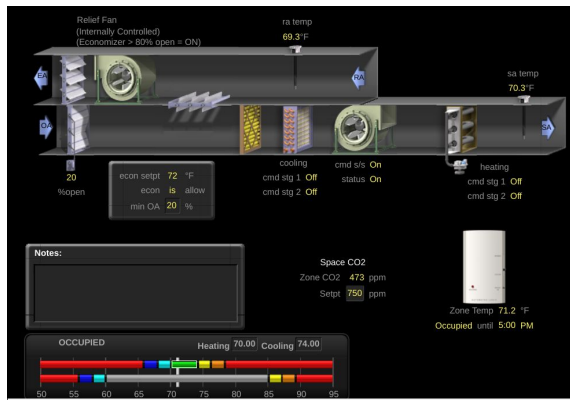


Image source: Google's WebCTRL instances.
WebCTRL is a building automation system owned by Automated Logic.

Building config

```
BLDG-1:
  type: FACILITIES/BUILDING

ZONE-1:
  connections:
    BLDG-1: CONTAINS
    AHU-1: FEEDS
  type: FACILITIES/ZONE

AHU-1:
  cloud device id: 1234
  connections:
    BLDG-1: CONTAINS
  type: HVAC/AHU_DFSS...
  translation:
    compressor run command :
      present_value: points.comp_cmd.present_value
      units:
        key: pointset.points.comp_cmd.units
        values:
          percent: '%'
    discharge air temperature_sensor :
      present_value:
        points.supply_air_temperature_sensor.present_value
        units:
          key: pointset.points.supply_air_temperature_sensor.units
          values:
            degrees_celsius: degC
  ...
```

Note: The building config sample is an abridged version of the full code. The ... indicates abbreviations in the code. Moving forward, you'll notice most samples in this module are shortened using

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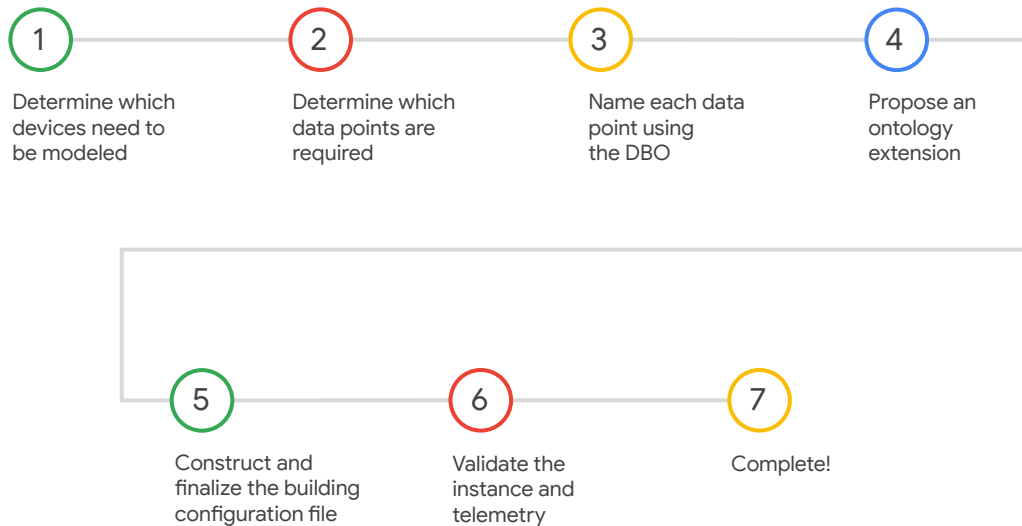
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Recommended workflow

Data modeling with the DBO is an art, not a science.

Much of your data modeling efforts will depend on your ability to accurately identify the equipment and systems that need to be modeled and how they can be described using the DBO. However, not everything you are likely to run into is currently described explicitly in DBO, and the building config will need to be tailored specifically to the site you are integrating.

Because of this, we can only recommend a workflow to guide your efforts. In general, data modeling begins with documents containing information, like mechanical schedules or controls submittals, about equipment installed (or being installed) in a building. The end result is a validated building configuration file that encodes this information in a common model.

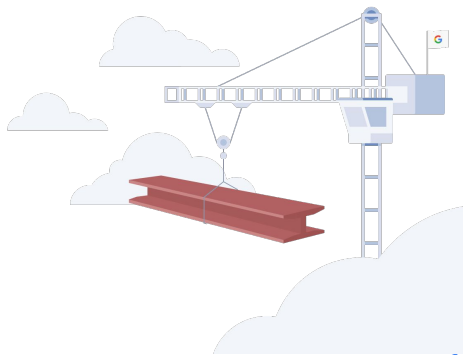
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Greenfield and brownfield sites

This module will focus primarily on the recommended workflow for modeling a **greenfield site**.

What's a greenfield site?

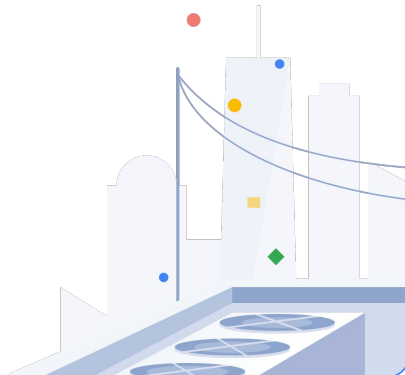
A **greenfield site** is a new construction. When modeling one, the equipment and systems are newly installed and made to conform with your project's standards from the outset of construction. However, they will be installed and configured at the same time as when you're constructing the building config file. Care will be needed to make sure these are synchronized properly.



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What's a brownfield site?

A **brownfield site** is an existing building. When modeling one, the equipment and systems are pre-determined. Integrating these systems can be straightforward, since all devices and their telemetry is well-understood from the outset. However, it can be challenging to conform everything to your project's standards, because what's in the building may not be common or fully translatable.

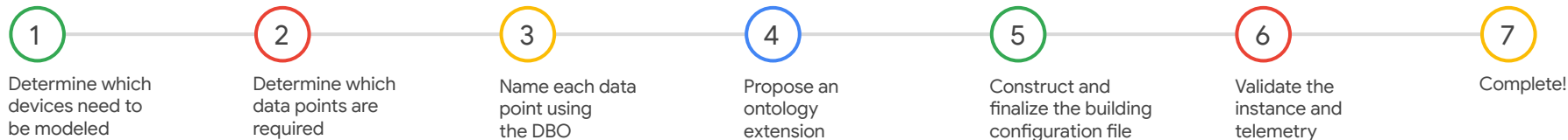


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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



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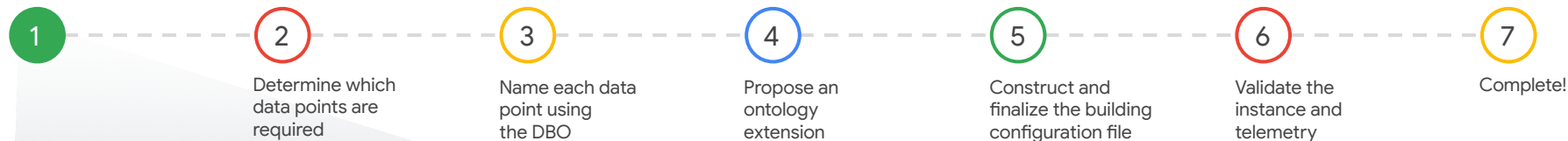
Note: Data integration is another important workflow you'll undergo simultaneously with this one. It involves installing and registering UDMI-compliant devices and gateways. You'll learn about the data integration workflow in another module.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



Determine which devices need to be modeled

Throughout the process, you'll receive or request project documents containing your scope of work and important information about the equipment and systems installed in the building. From these, you'll identify the reporting devices from each namespace that need to be modeled and integrated into Google Cloud IoT Core.

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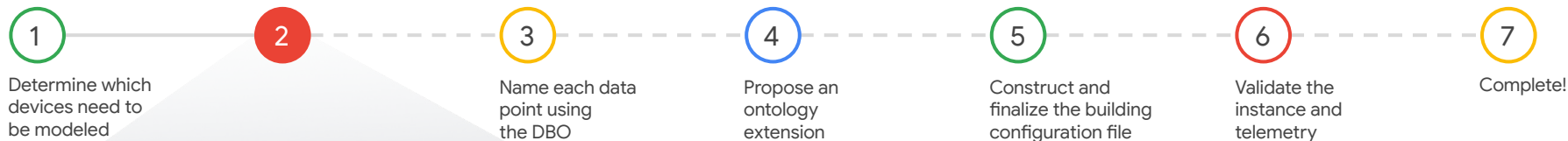
Note: [Lesson 2](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



Determine which data points are required

You'll individually examine each logical entity that needs to be modeled using the project documents you received. You'll differentiate between important data points that are required by your project from others that are optional.

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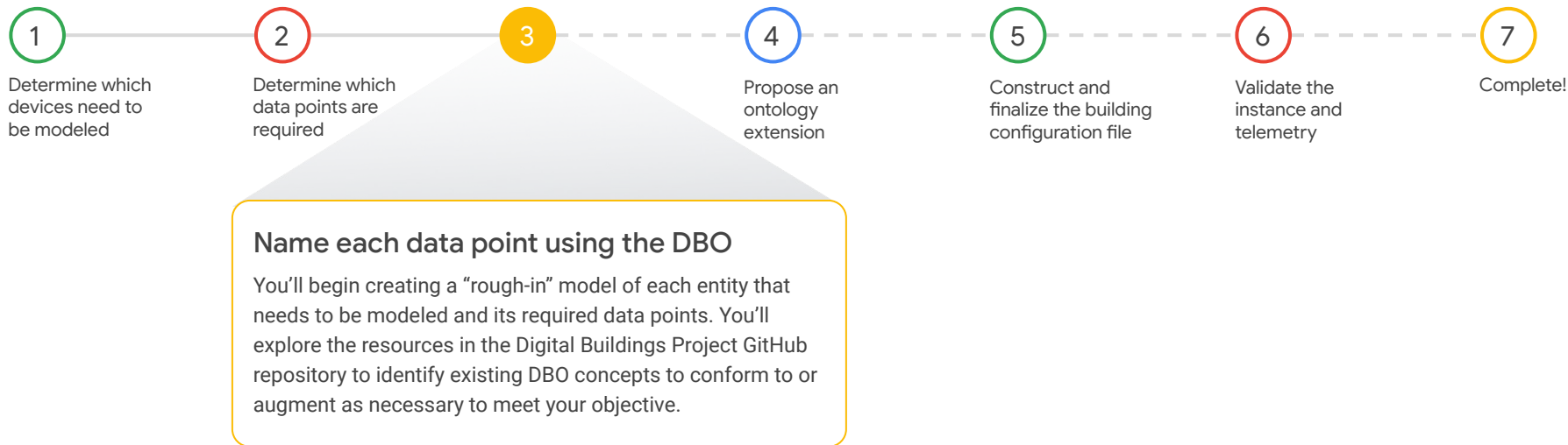
Note: [Lesson 3](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



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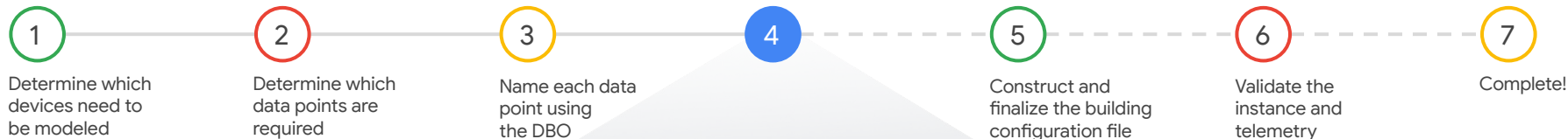
Note: [Lesson 4](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



Propose an ontology extension

You may find that the DBO doesn't have a concept that can describe parts of or all of the entity you're modeling. If this happens, then you'll need to propose an ontology extension to add new models to the DBO.

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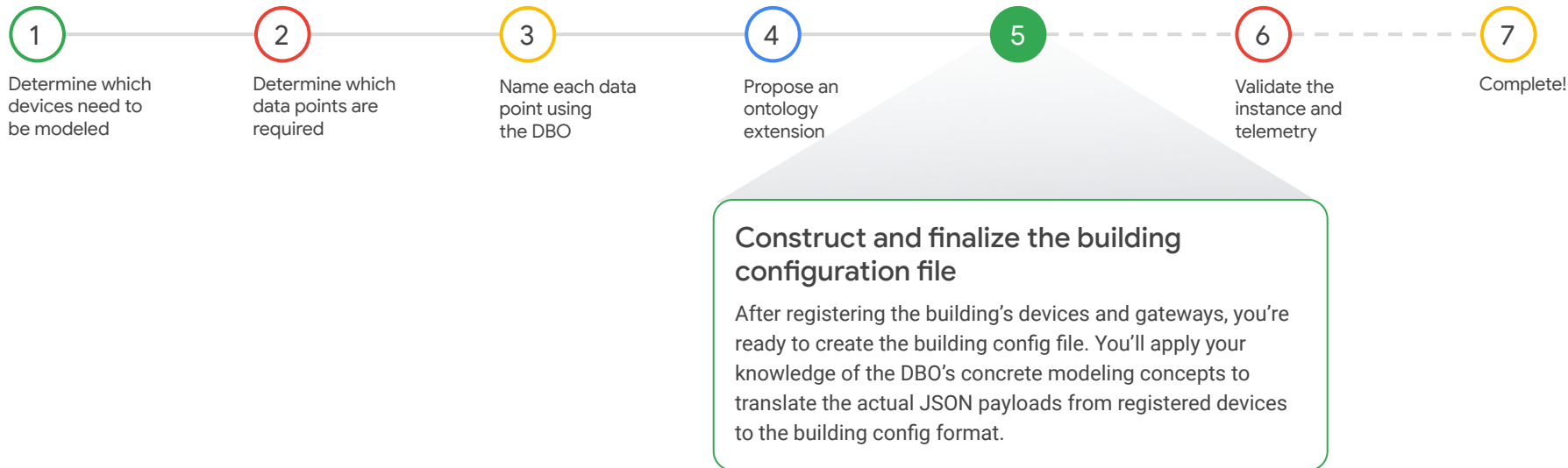
Note: [Lesson 5](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



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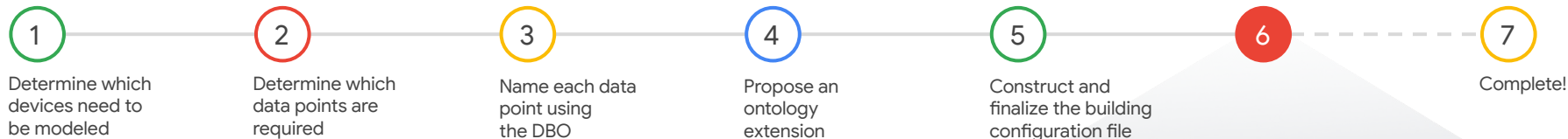
Note: [Lesson 6](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



Validate the instance and telemetry

As you construct the building config, it's critical to ensure it fully conforms to the DBO. You'll need to validate the instance and the mapped telemetry frequently before completing it for your project.

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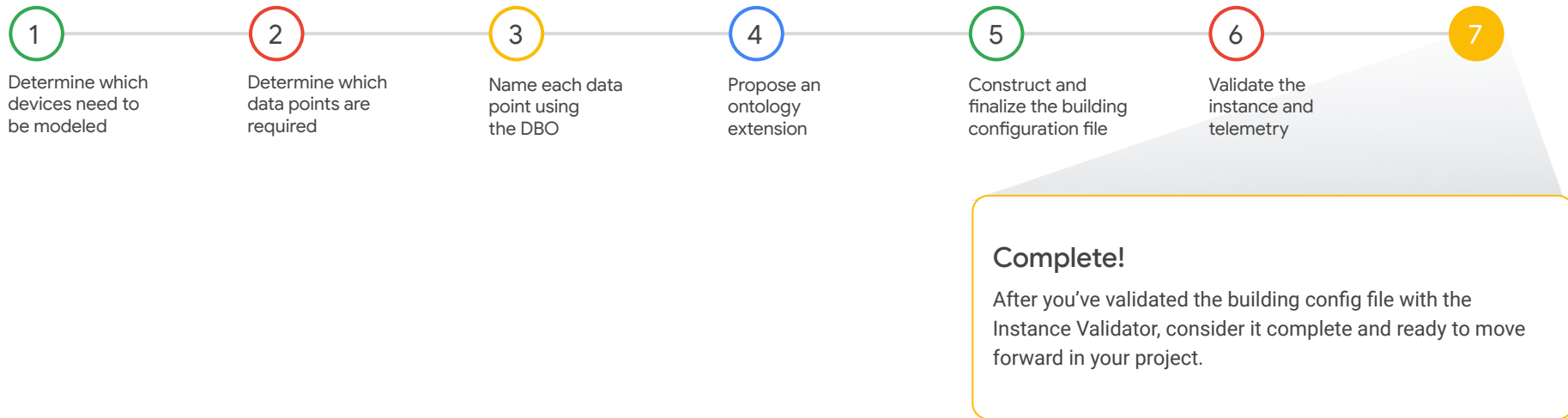
Note: [Lesson 7](#) of this module will focus on this workflow step.

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Recommended workflow

Here's the workflow we recommend following:

Click on each step in the workflow to reveal a brief description about it.



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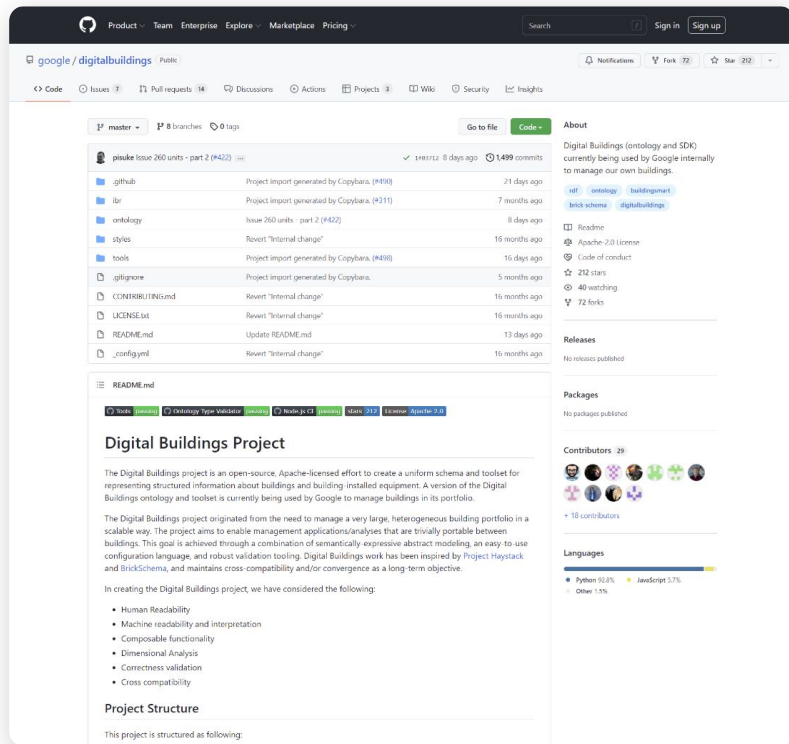
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Resources

The Digital Buildings Project GitHub repo has all the resources you need for data modeling with the DBO.

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Resources

The [Digital Buildings Project GitHub repo](#) has all the resources you need for data modeling.

Click on each type of resource to reveal a list of links.

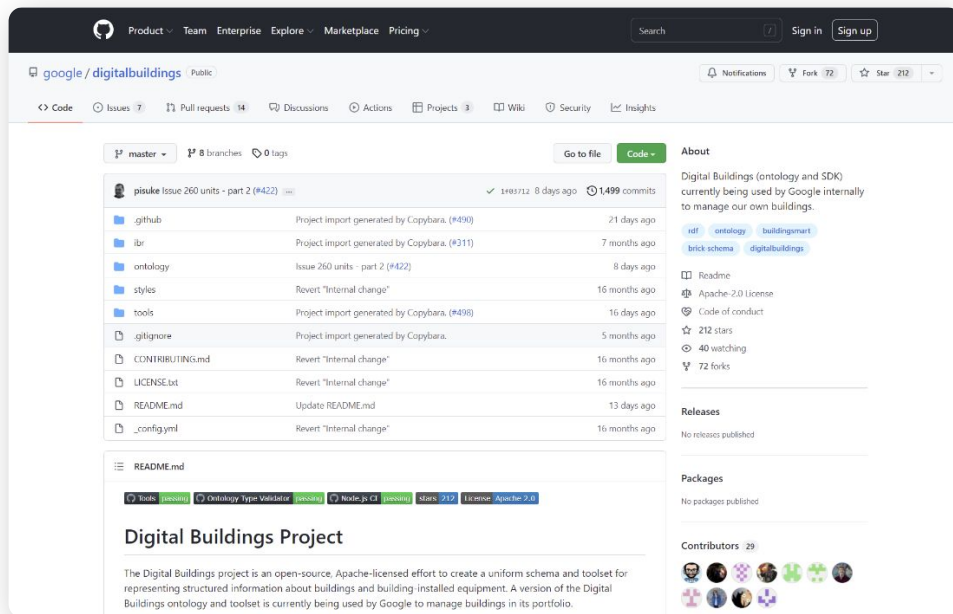
DBO documentation

Building config samples

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The [Digital Buildings Project GitHub repo](#) has all the resources you need for data modeling.

Click on each type of resource to reveal a list of links.

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DBO documentation

The following docs can be found in [digitalbuildings / ontology / docs](#):

- [Ontology Overview](#)
Describes the structure and principles of the Digital Buildings Ontology (DBO).
- [Frequently Asked Questions \(FAQ\)](#)
Answers common questions about using the DBO to model building equipment.
- [Abstract Model](#)
Describes the conventions used in the DBO abstract model.
- [Building Configuration](#)
Describes the building configuration format for mapping concrete assets.
- [Ontology Configuration](#)
Explains how to write building configuration files using what's provided in the global and child namespaces.
- [HVAC Model](#)
Outlines the best practices, general types, and abstract types for data modeling in the HVAC namespace.

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Resources

The [Digital Buildings Project GitHub repo](#) has all the resources you need for data modeling.

Click on each type of resource to reveal a list of links.

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Building config samples

The following samples from the HVAC namespace can be found in [digitalbuildings / ontology / docs](#):

- [Air handling units \(AHU\)](#)
Includes single zone and multi-zone AHUs and an AHU as part of a dual duct system.
- [Chilled and condensing water systems \(CHWS and CWS\)](#)
Includes an air-cooled and water-cooled variable primary CHWS.
- [Fan coil units \(FCU\)](#)
Includes a stand-alone FCU, an FCU and VAV tandem zone, and an FCU with local exhaust control.
- [Heating water systems \(HWS\)](#)
Includes a variable primary HWS.

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The [Digital Buildings Project GitHub repo](#) has all the resources you need for data modeling.

Click on each type of resource to reveal a list of links.

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Global and child namespaces

The DBO namespaces can be found in [digitalbuildings / ontology / yaml / resources](#):

Global namespace

- [Subfields](#)
- [Units](#)
- [Fields](#)
- [States](#)
- [Entity types](#)
- [Connections](#)

Child namespaces

- [Carson](#)
- [Electrical](#)
- [Facilities](#)
- [Gateways](#)
- [HVAC](#)
- [Info Tech](#)
- [Lighting](#)
- [Meters](#)
- [Physical Security](#)
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The [Digital Buildings Project GitHub repo](#) has all the resources you need for data modeling.

Click on each type of resource to reveal a list of links.

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Tooling

The following tools can be found in [digitalbuildings / tools](#):

- [Ontology Validator](#)
Used to validate an ontology extension to ensure it conforms to the DBO.
- [Instance Validator](#)
Used to validate a building configuration file to ensure it conforms to the DBO.
- [Ontology Explorer](#)
Used to ask basic questions of what's curated within the DBO.
- [GUID Generator](#)
Used to generate and assign GUIDs to entities in a building config file.

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Resources

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Click on each type of resource to reveal a list of links.

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GitHub resources

Need general help with GitHub? Outside of the Digital Buildings repo, [GitHub Docs](#) has a collection of help articles for working and collaborating with GitHub. The following should be useful for DBO data modeling:

- [Fork a repo](#)
Outlines how to fork (or create a copy of) the Digital Buildings GitHub repo for you to freely experiment and modify without affecting the published version.
- [Contributing to projects](#)
Includes information about forking, cloning, changes, pull requests, and more to help you get started with GitHub projects like the Digital Buildings Project.

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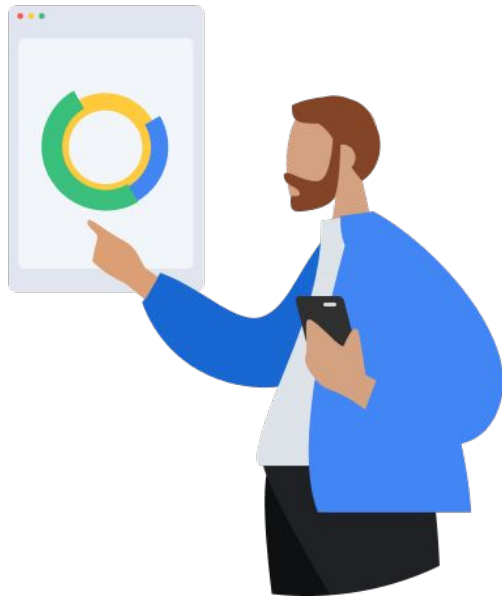
Lesson 1 summary

Let's review what you learned about:

- "Good" building configuration files
- Greenfield and brownfield sites
- Recommended data modeling workflow
- Data modeling resources

Now you should be able to:

- Reference "good" examples of building configuration files.
- Understand the difference between a greenfield and brownfield site.
- Recall the recommended data modeling workflow.
- Find helpful tooling, documentation, and references for DBO data modeling.



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You completed Lesson 1!

Now's a great time to take a quick break before starting Lesson 2.

Ready for Lesson 2?

Let's go!

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Helpful resources

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

- [Digital Buildings Project GitHub](#)
Contains source code, tooling, and documentation for the DBO.