krellian™

Smart Building Solutions

built on WebThings®

Ben Francis
Founder

Businesses are wasting money on underutilised and inefficient buildings

59%

Reduced office space requirements

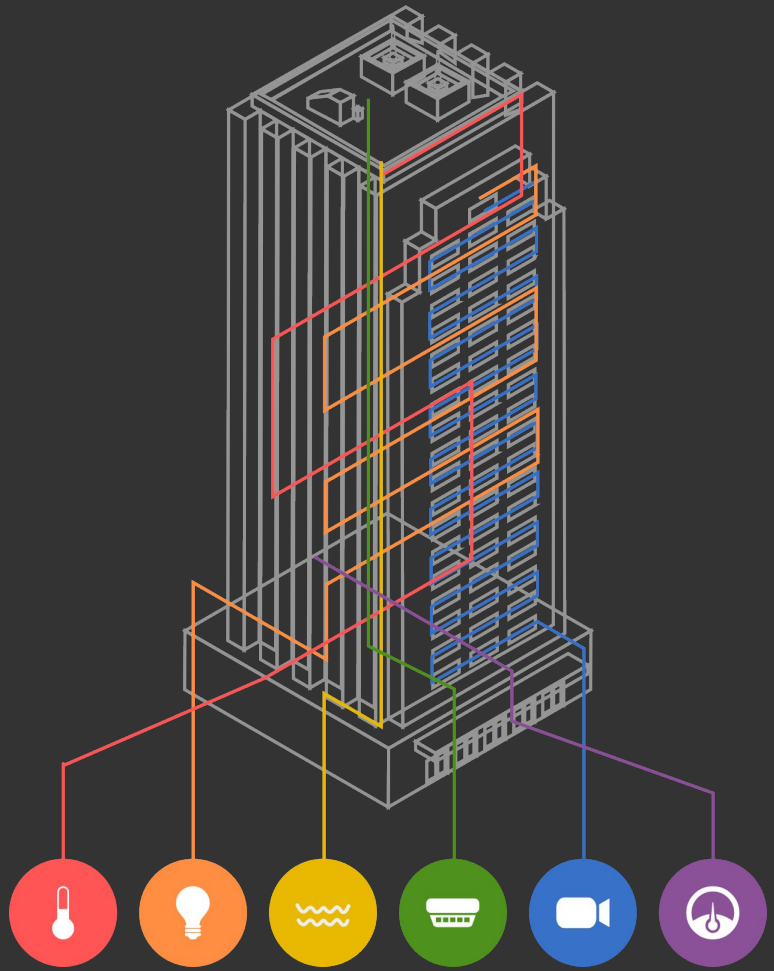
292%

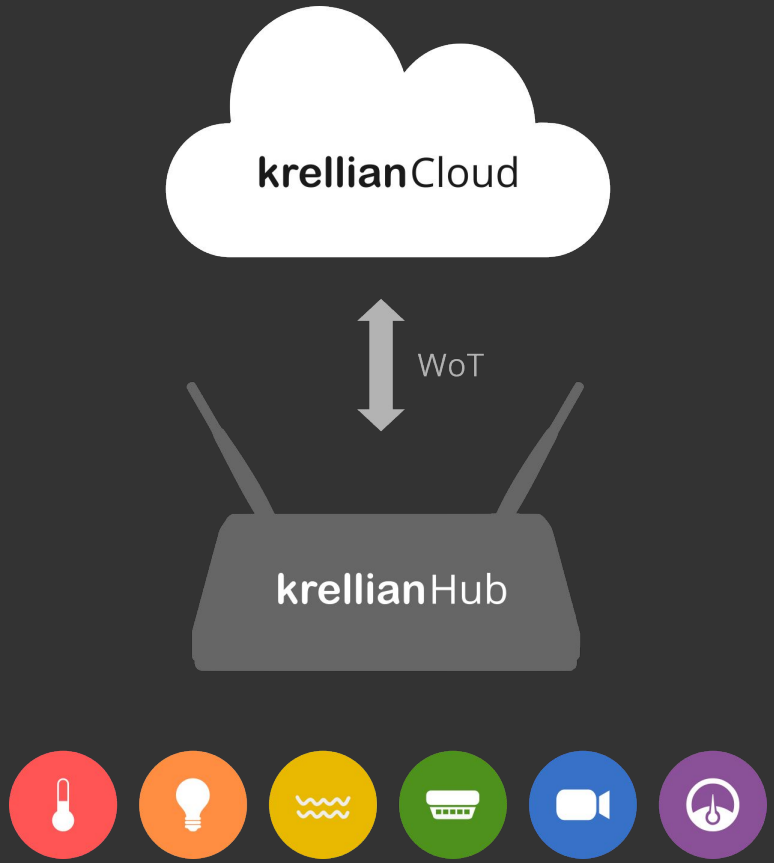
Increase in energy prices

£6bn

Potential energy efficiency savings

Sources: Siemens Space Race Report, 2021; Ofgem, May 2022; Green Alliance policy insight, January 2020

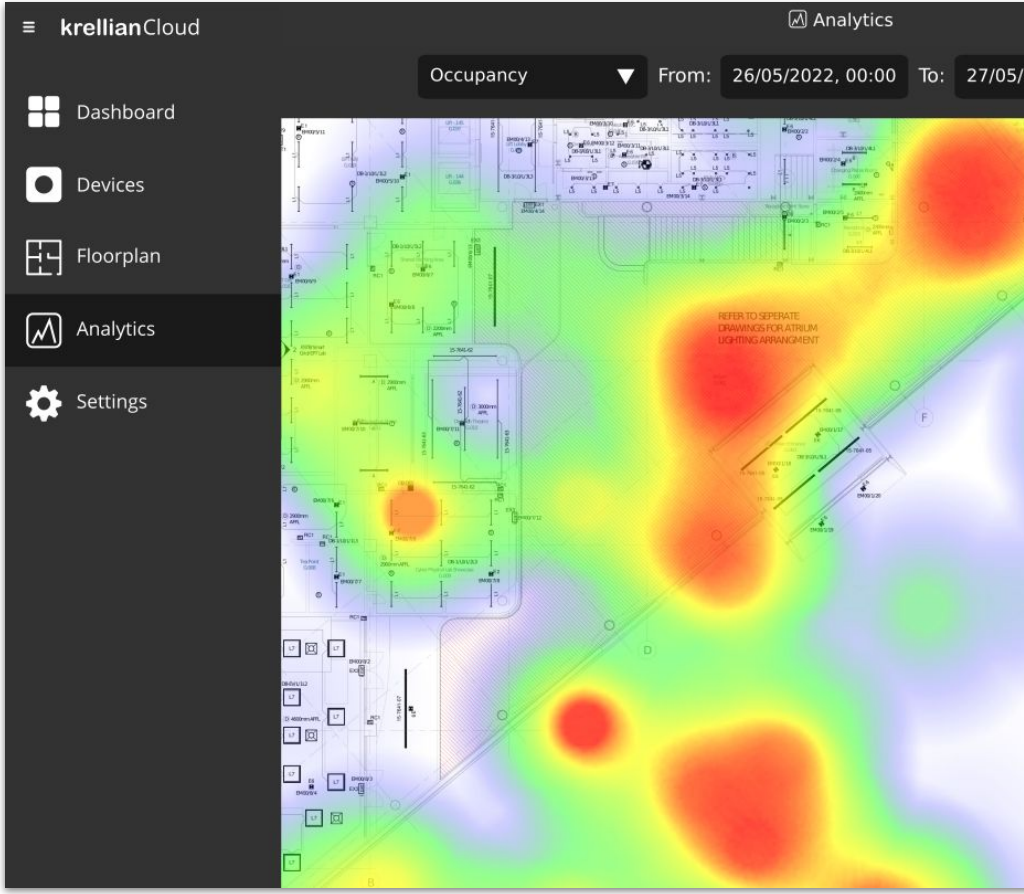



krellianCloud
WoT
krellianHub

*Helps **facilities managers** meet their **net zero** targets whilst **saving money***

Space Utilisation

Energy Consumption



Innovate UK Funded Project

Krellian Smart Buildings - Helping Facilities Managers meet their Net Zero Targets

Objectives

1. Implement an MVP of Krellian Cloud to provide real-time data analytics for smart buildings
2. Make WebThings Gateway conformant with the latest W3C WoT standards

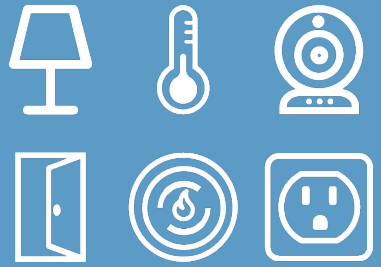

WebThings

WebThings

An open platform for monitoring and controlling devices over the web.

WebThings Gateway

A software distribution for smart home hubs focused on privacy, security and interoperability

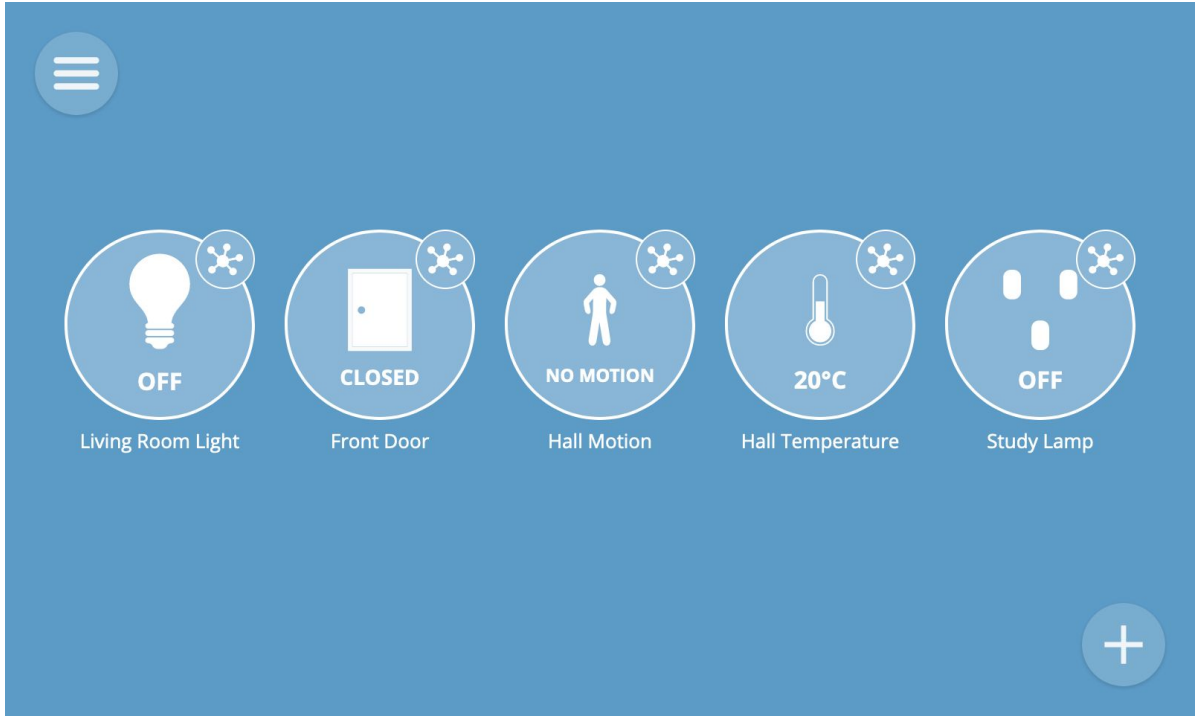


WebThings Framework

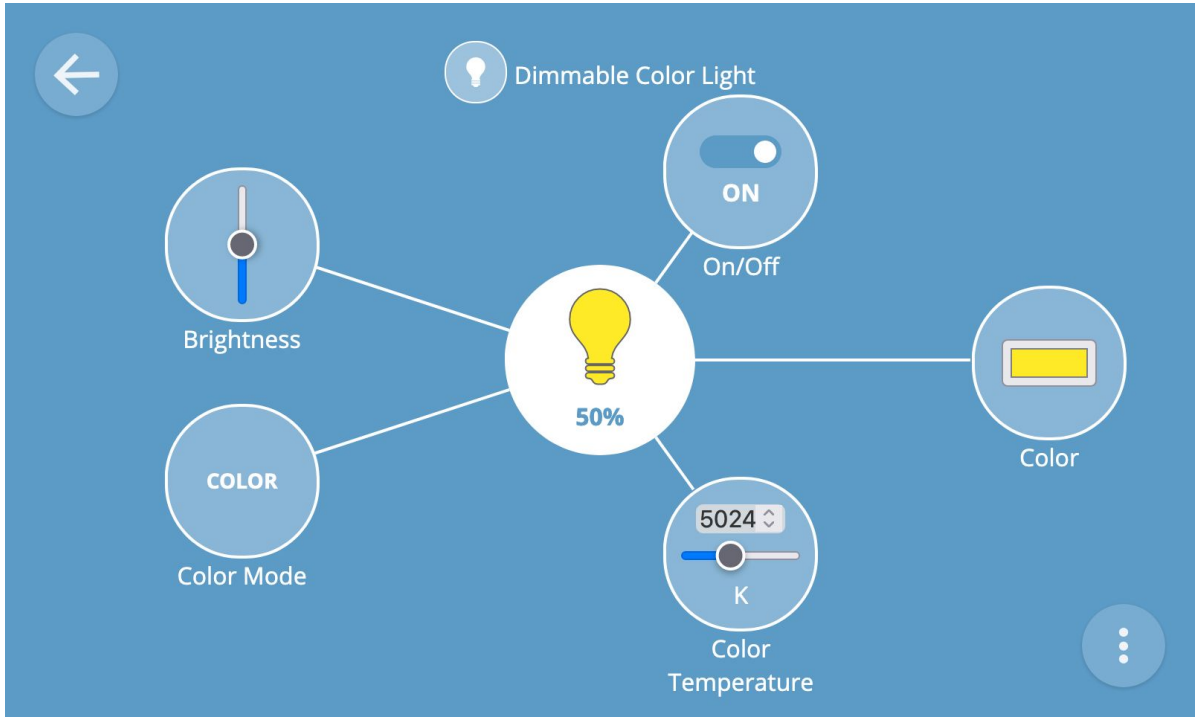
A collection of reusable software components to help developers build their own web things

webthings.io

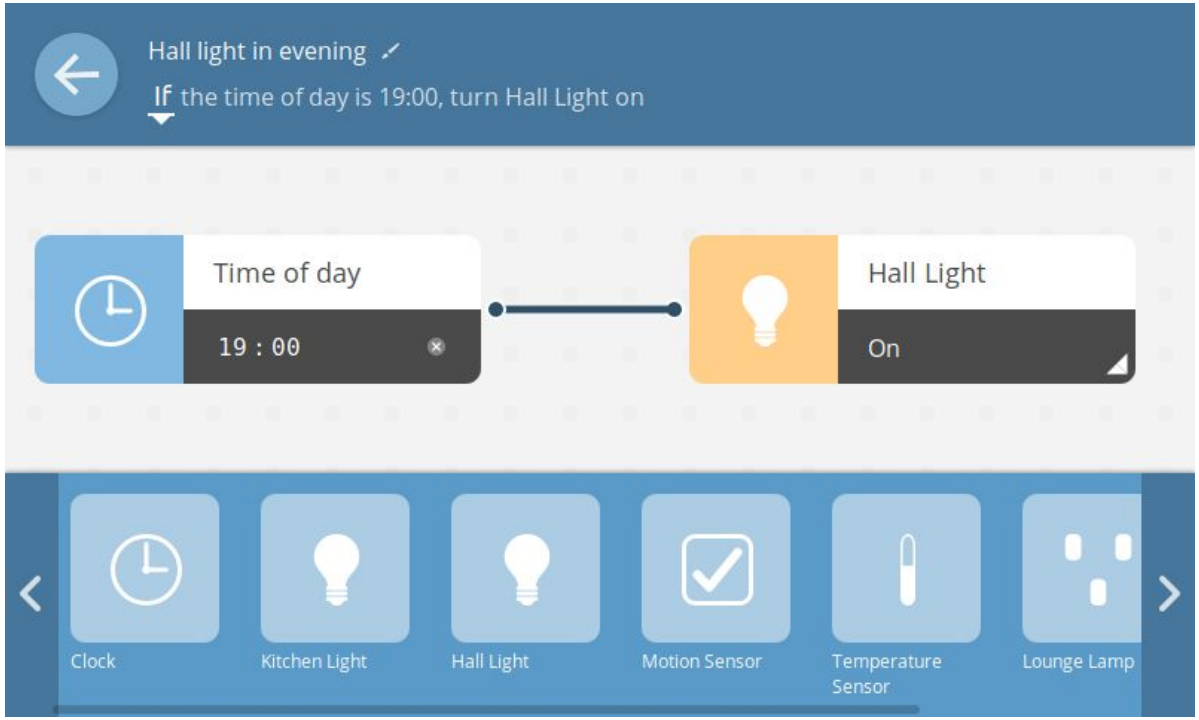
Things


OFF
Living Room Light
CLOSED
Front Door
NO MOTION
Hall Motion
20°C
Hall Temperature
OFF
Study Lamp

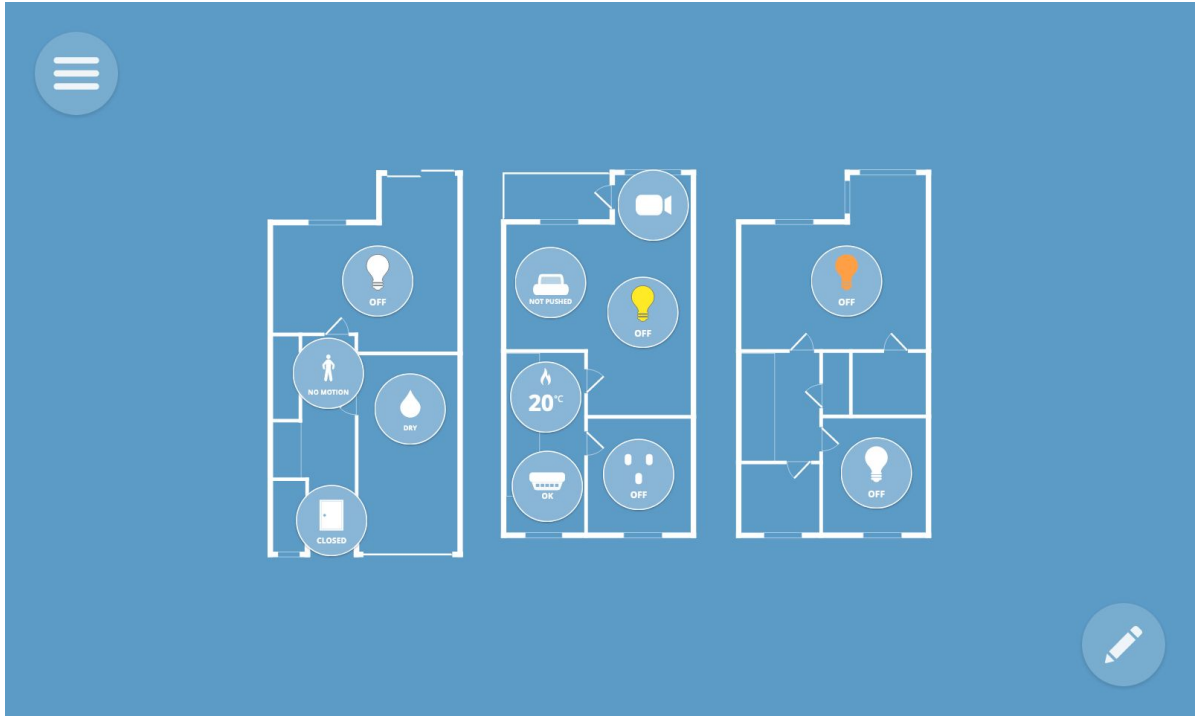
Thing


Dimmable Color Light
ON
On/Off
Brightness
50%
Color
COLOR
Color Mode
5024
K
Color
Temperature

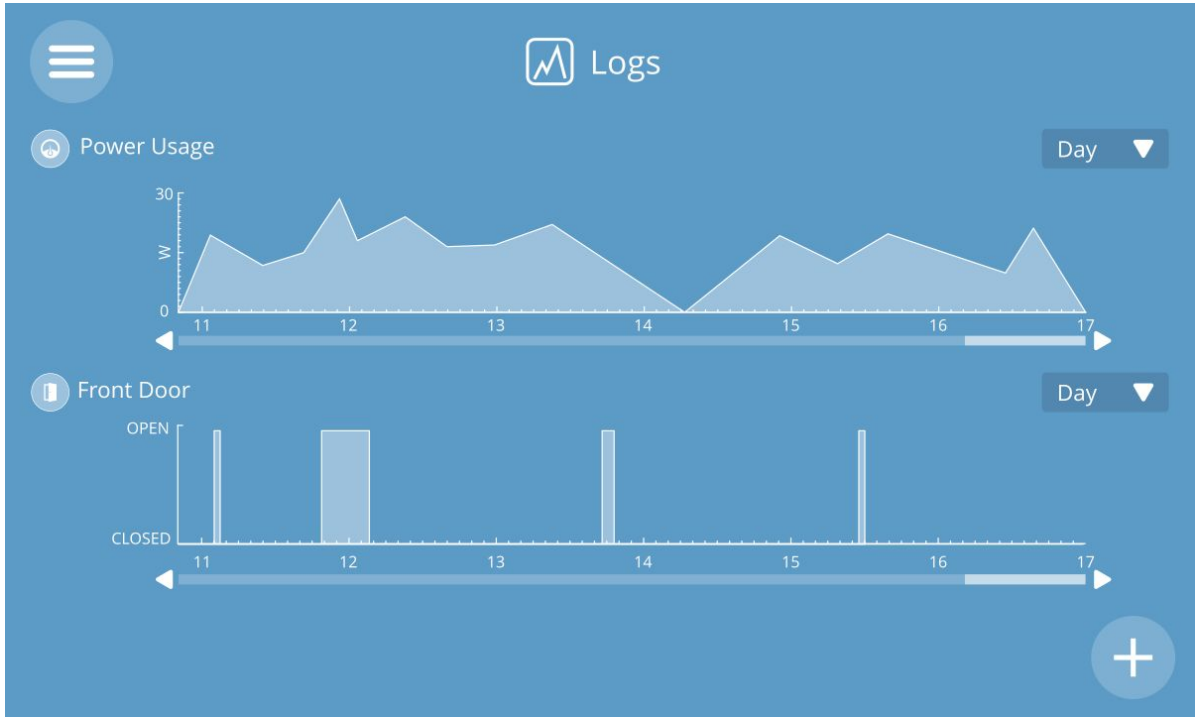
Rules


Hall light in evening
If the time of day is 19:00, turn Hall Light on
Time of day
19 : 00
Hall Light
On
Clock
Kitchen Light
Hall Light
Motion Sensor
Temperature Sensor
Lounge Lamp

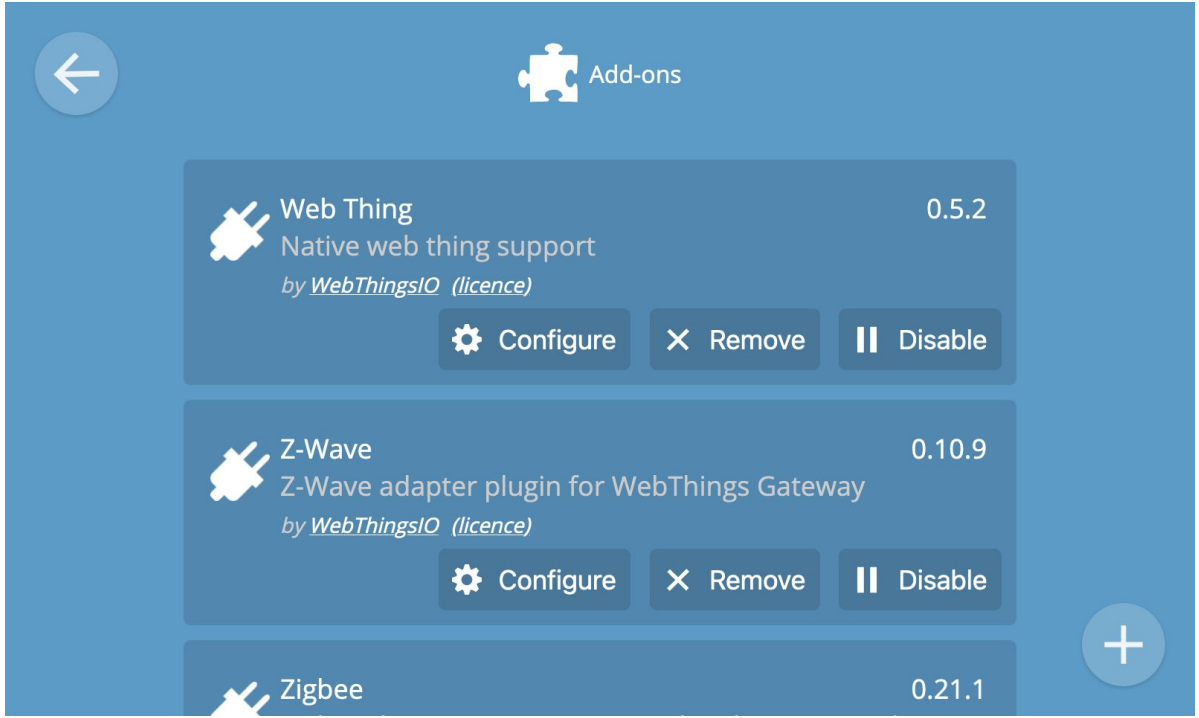
Floorplan



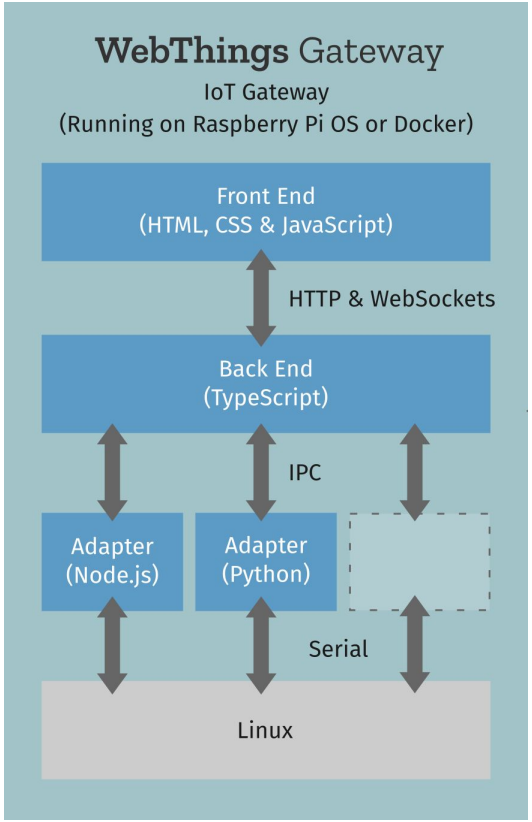
Logging


Logs
Power Usage
Day
30
W
0
11
12
13
14
15
16
17
Front Door
Day
OPEN
CLOSED
11
12
13
14
15
16
17

Add-ons


Add-ons
Web Thing
0.5.2
Native web thing support
by WebThingsIO (licence)
Configure
Remove
Disable
Z-Wave
0.10.9
Z-Wave adapter plugin for WebThings Gateway
by WebThingsIO (licence)
Configure
Remove
Disable
Zigbee
0.21.1

Architecture



W3C Standards Compliance

- ✔ WoT Thing Description 1.1 Producer
- ✔ WoT Profiles 1.0 Producer
  - ✔ HTTP Basic Profile
  - ✔ HTTP SSE Profile

krellianCloud

krellianCloud

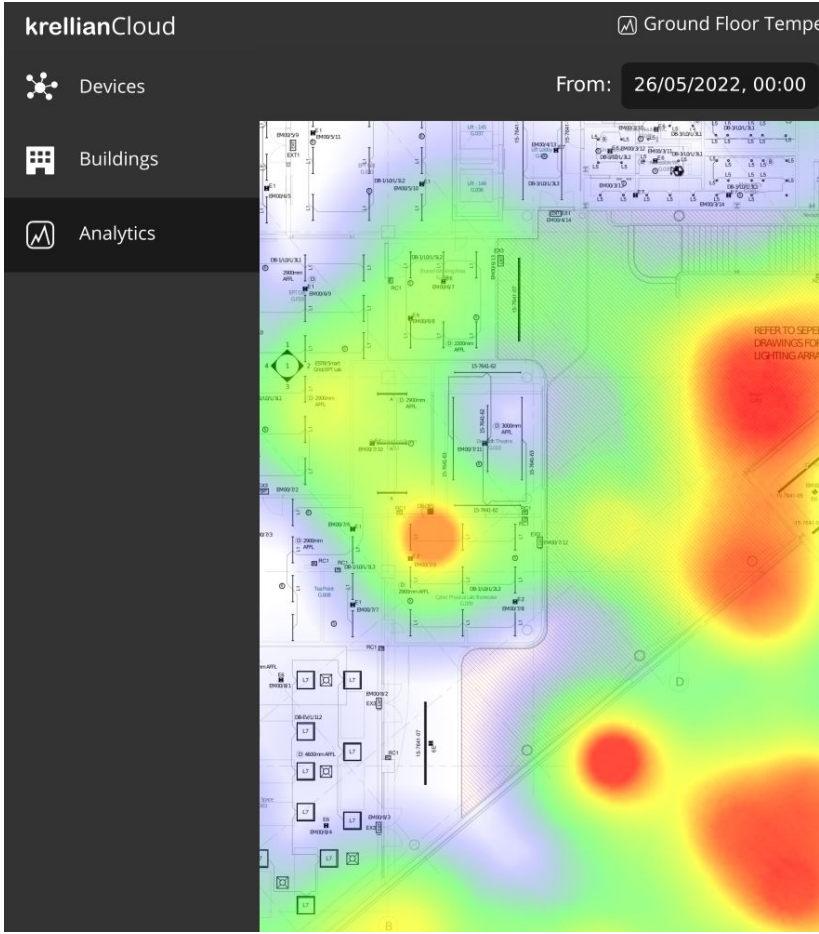
Real-time data analytics for buildings to model how they're being used and identify potential optimisations.

Occupancy

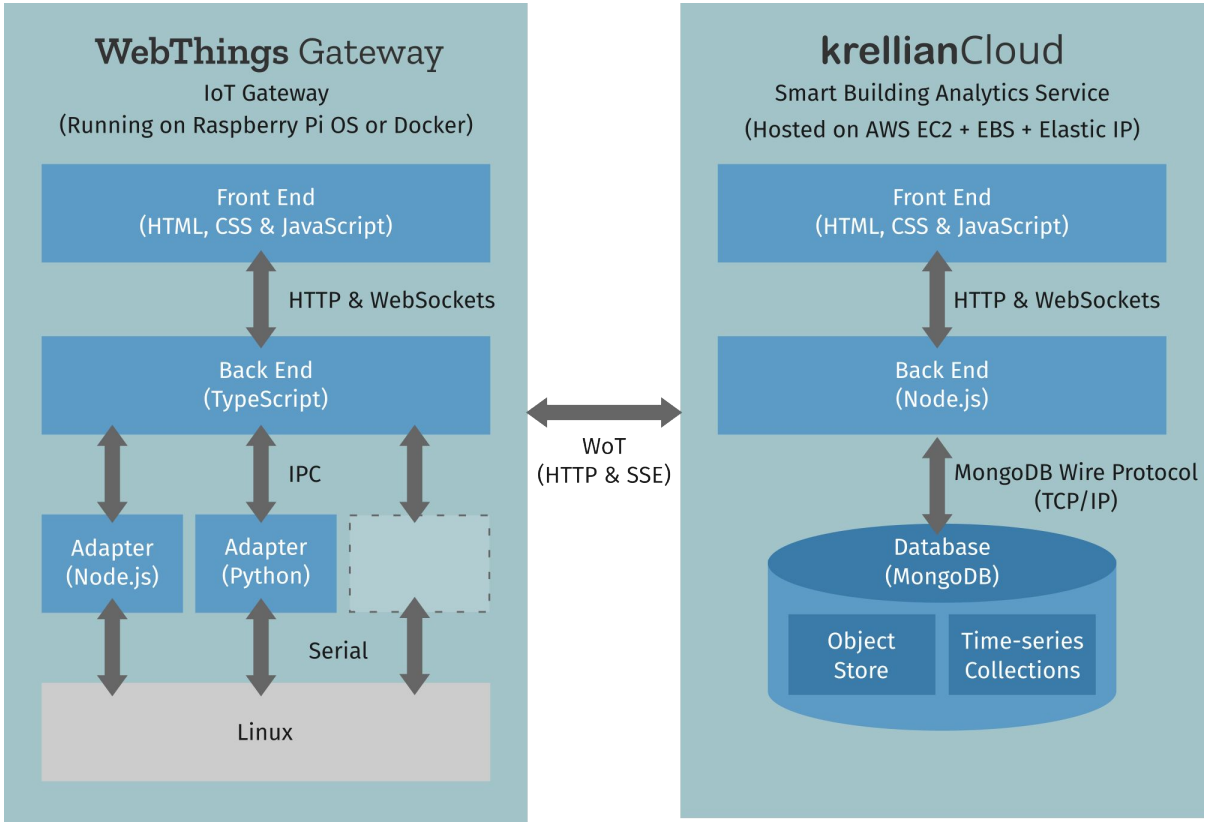
Energy

Safety

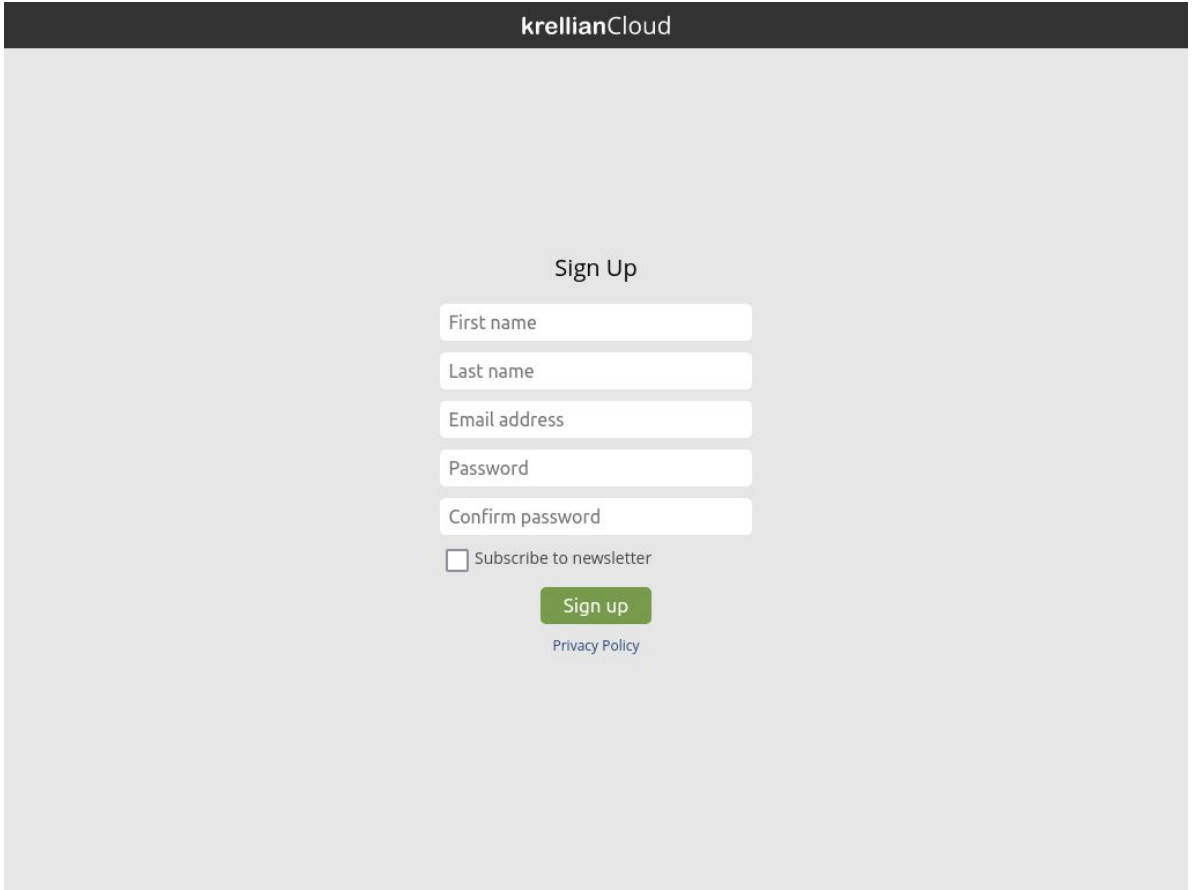
krellian.com/cloud



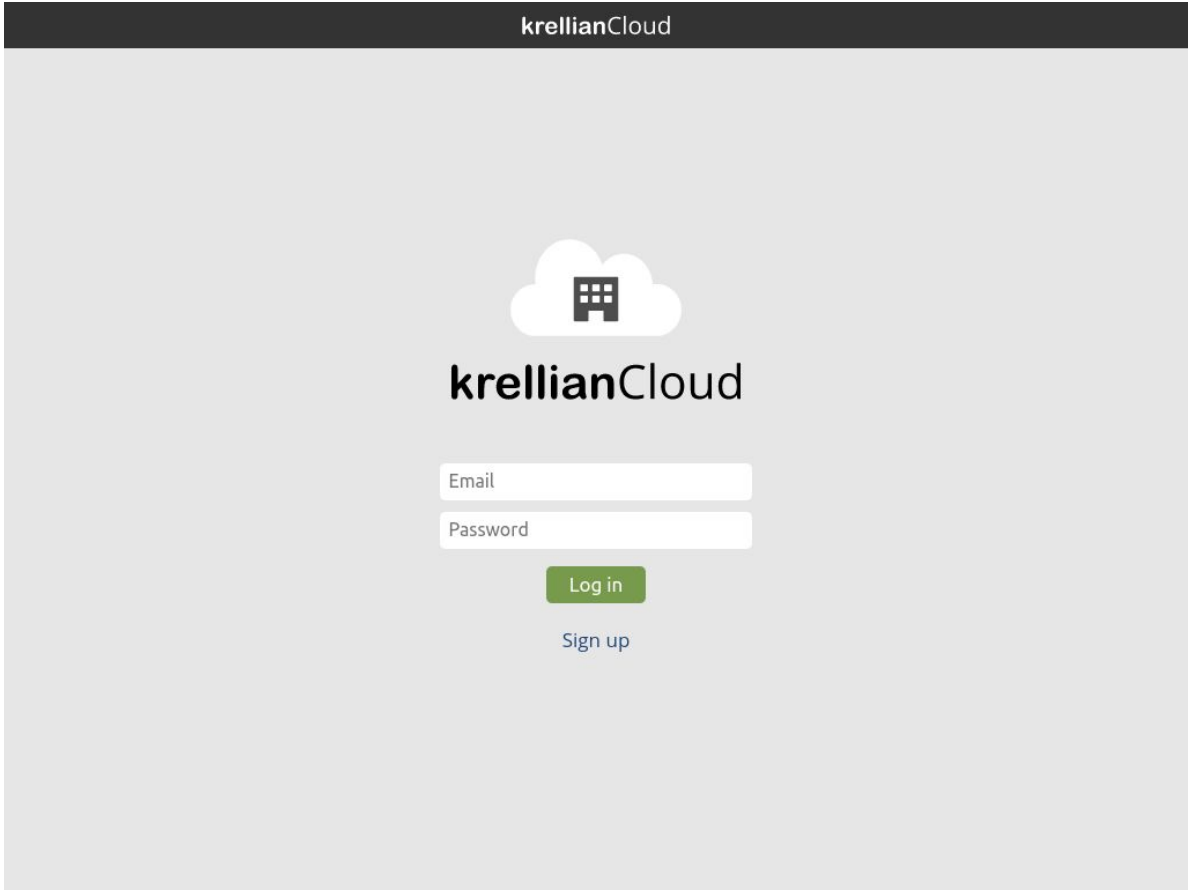
WebThings Gateway + **krellian**Cloud



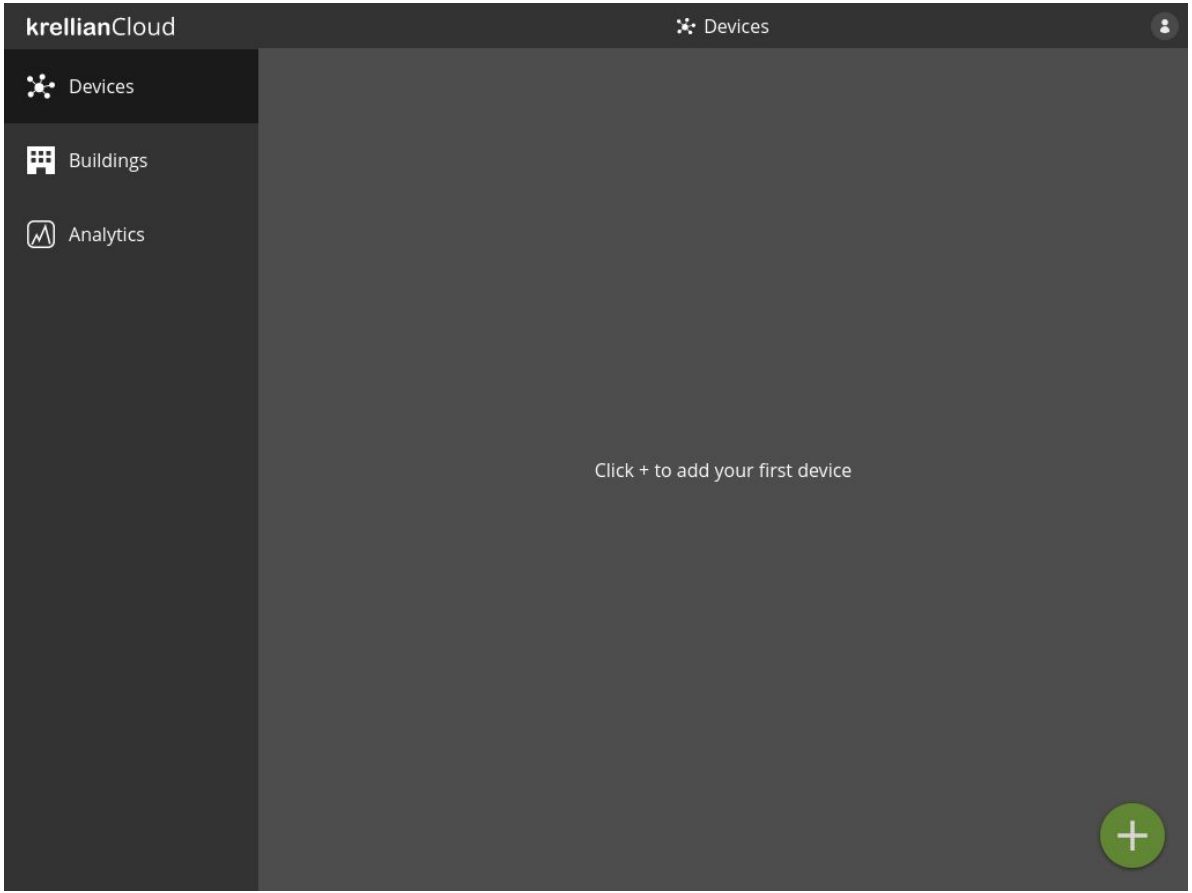
Sign Up


krellianCloud
Sign Up
First name
Last name
Email address
Password
Confirm password
Subscribe to newsletter
Sign up
Privacy Policy

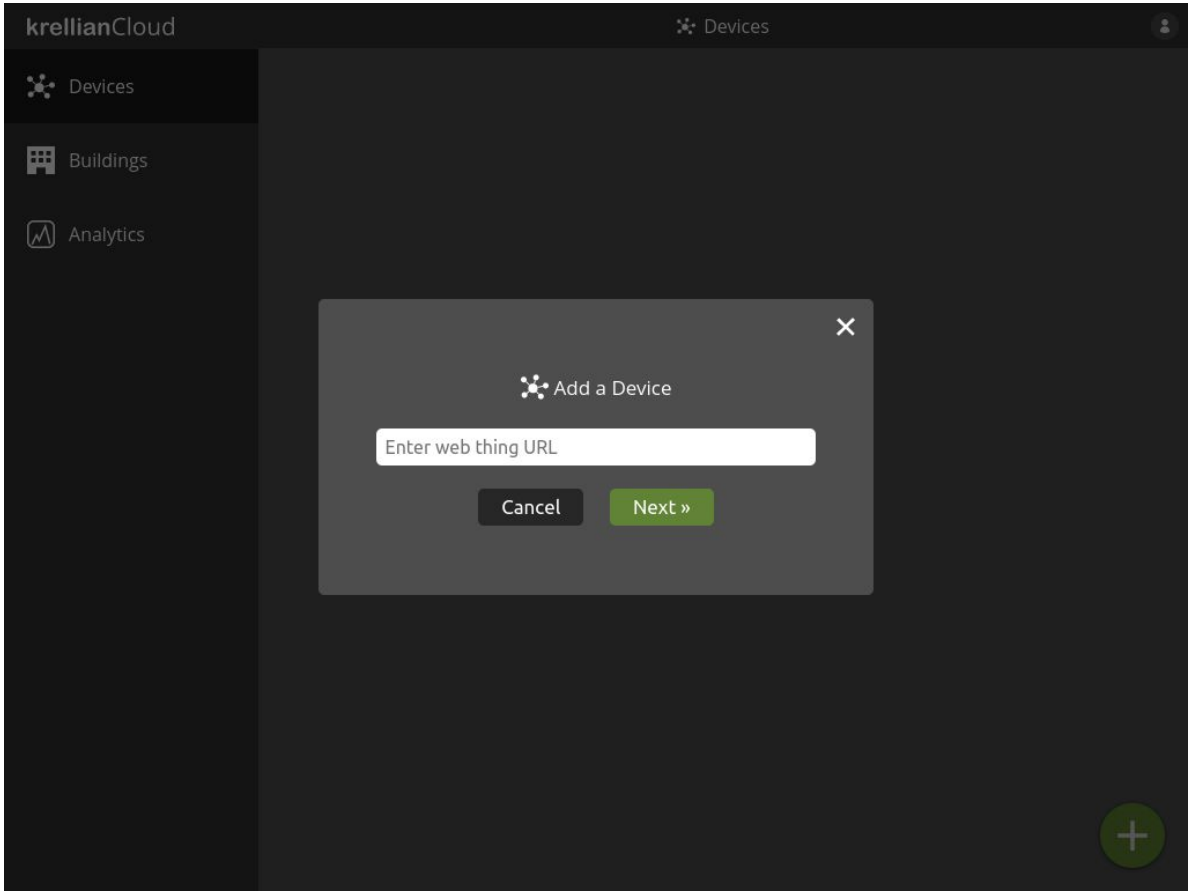
Log In


krellianCloud
krellianCloud
Email
Password
Log in
Sign up

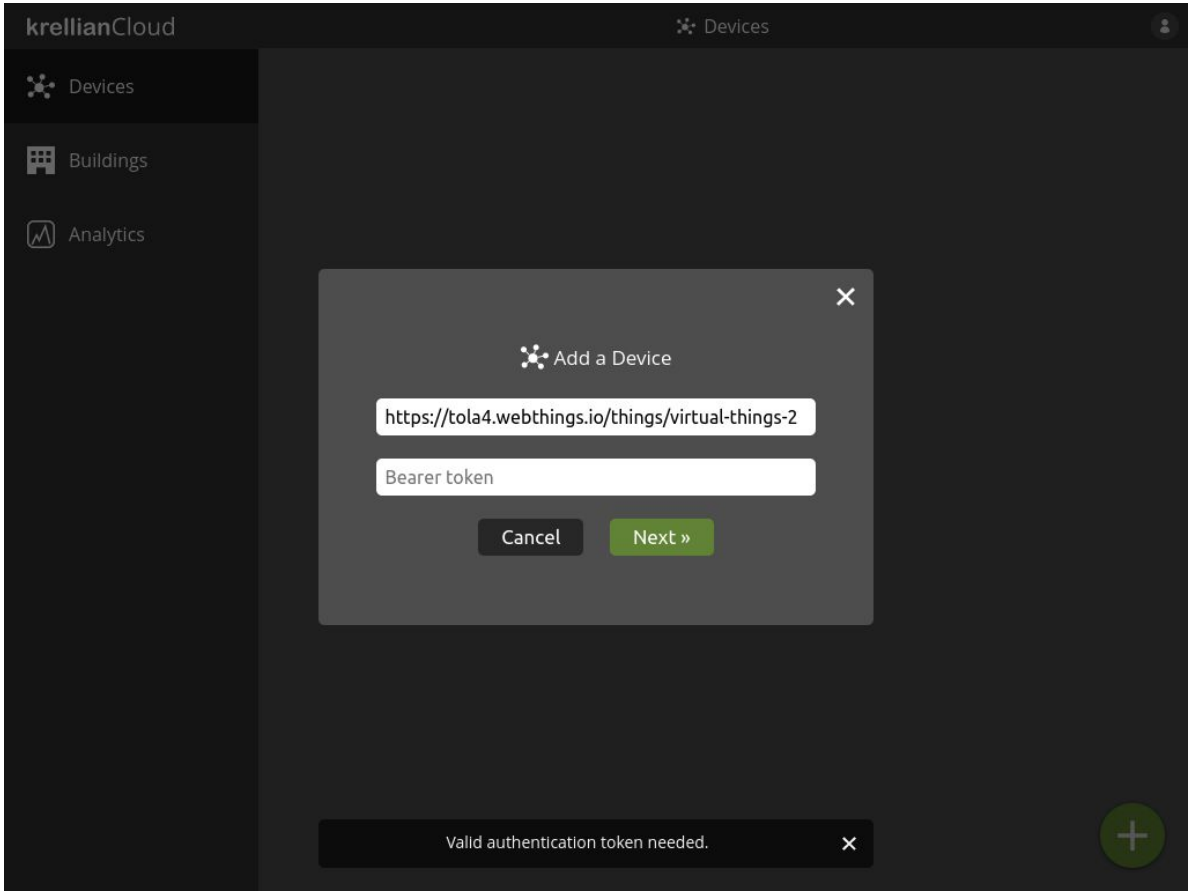
Devices


krellianCloud
Devices
Devices
Buildings
Analytics
Click + to add your first device

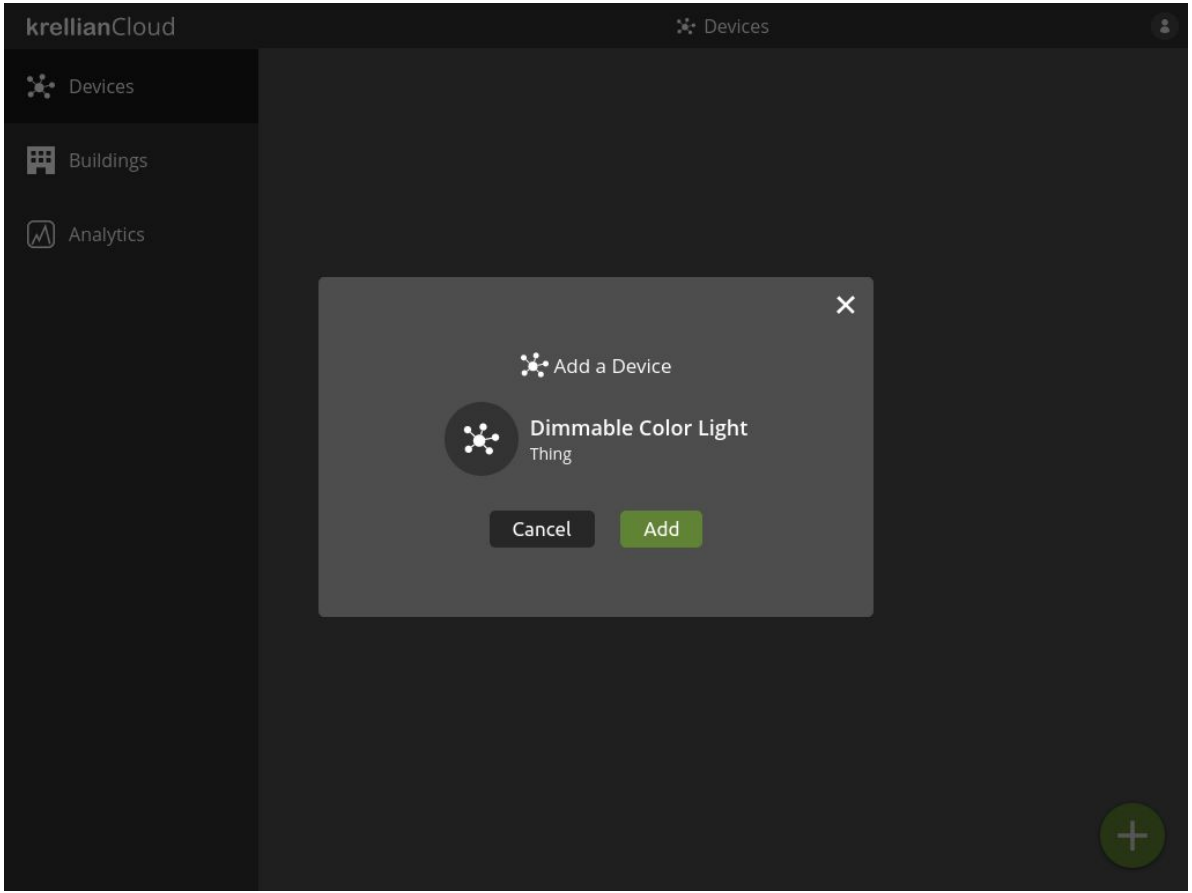
Add Device


krellianCloud
Devices
Devices
Buildings
Analytics
Add a Device
Enter web thing URL
Cancel
Next »

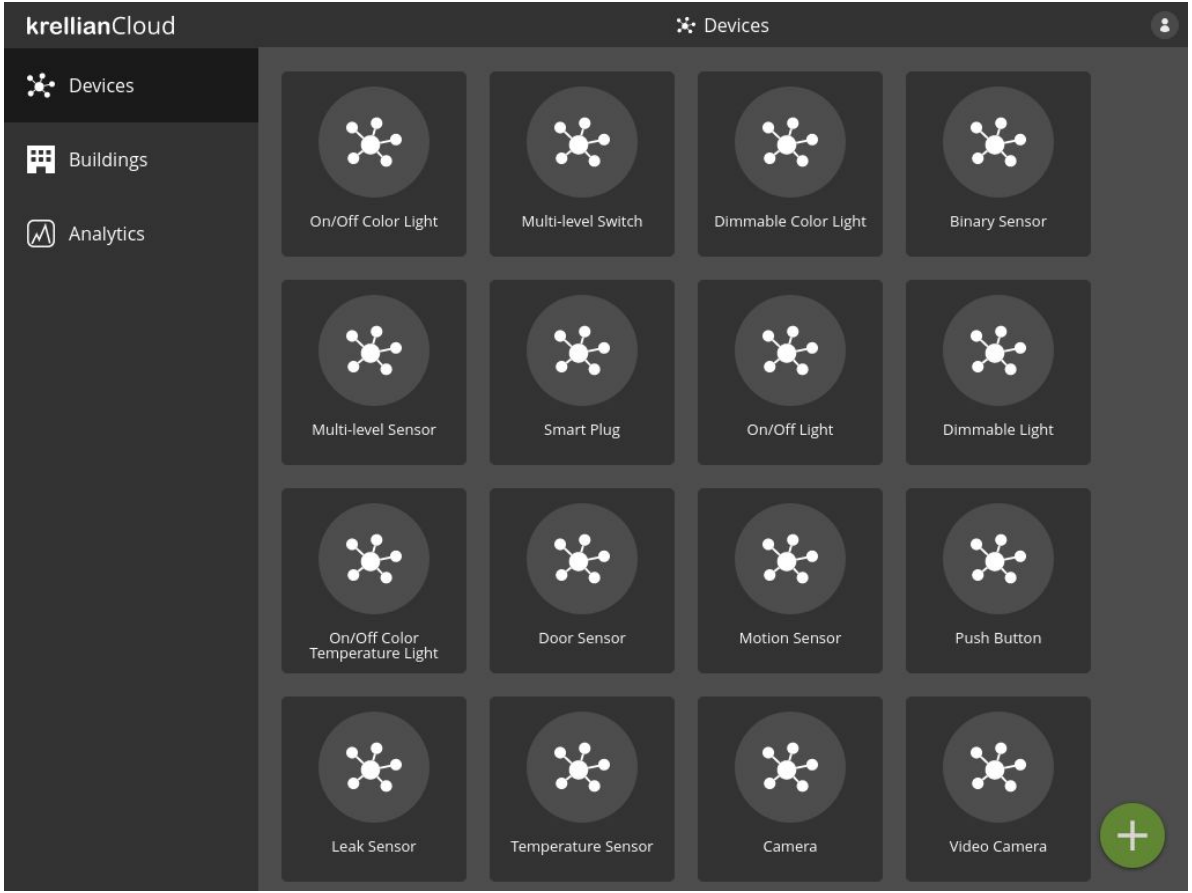
Authenticate Device



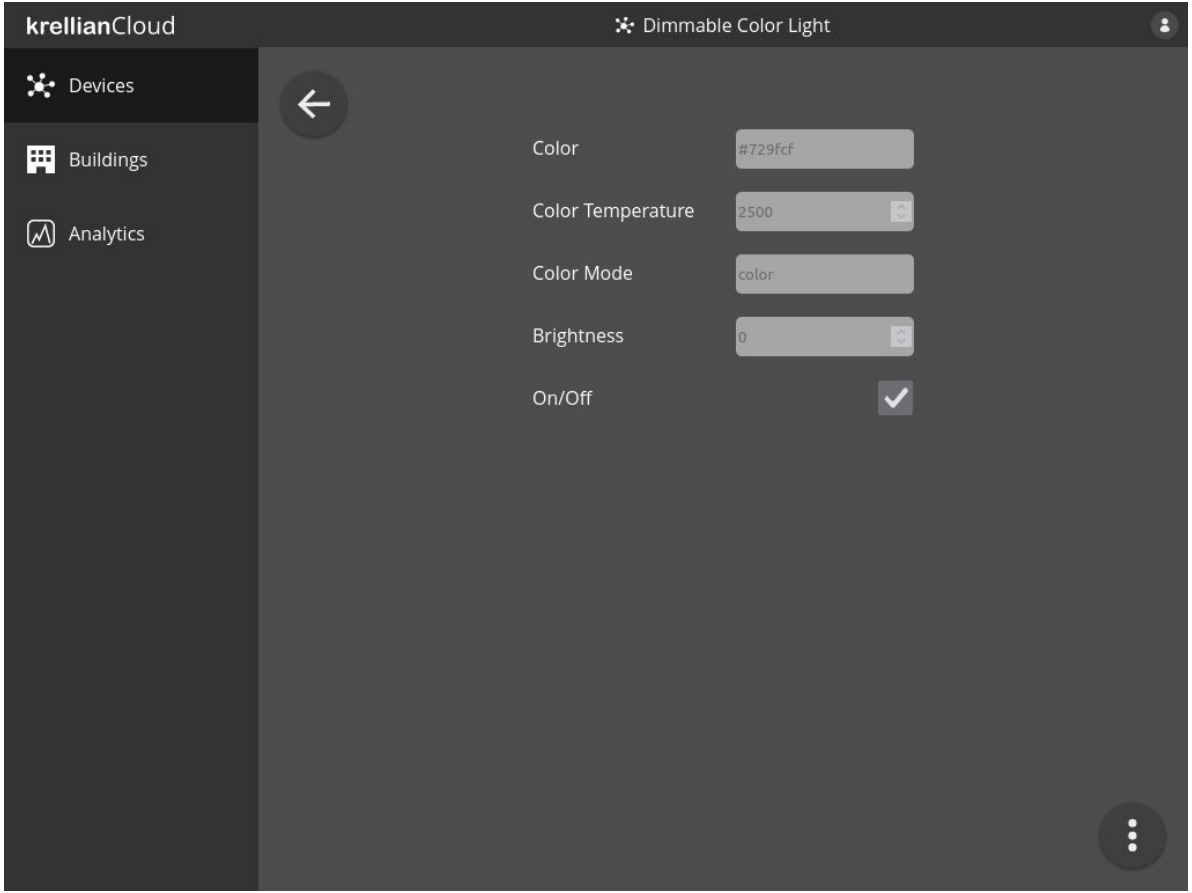
Preview Device



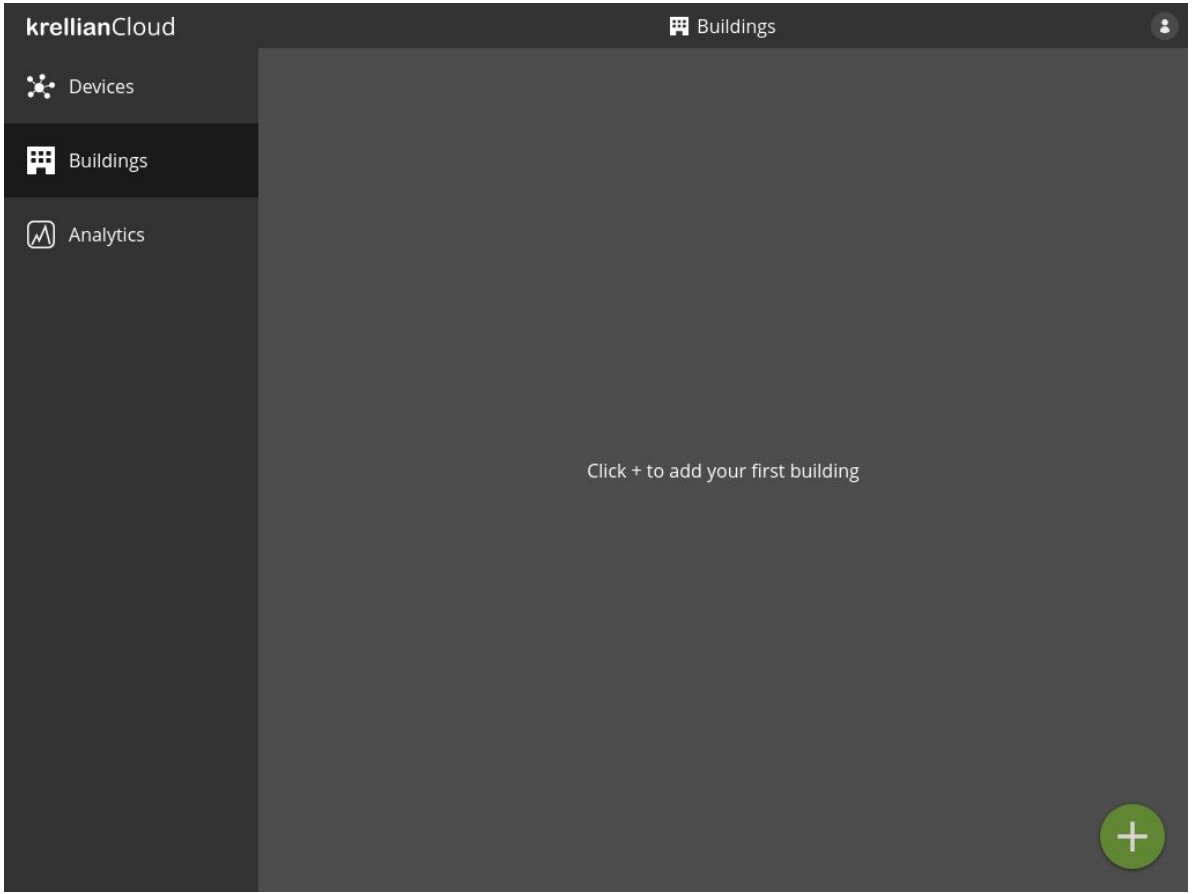
List Devices



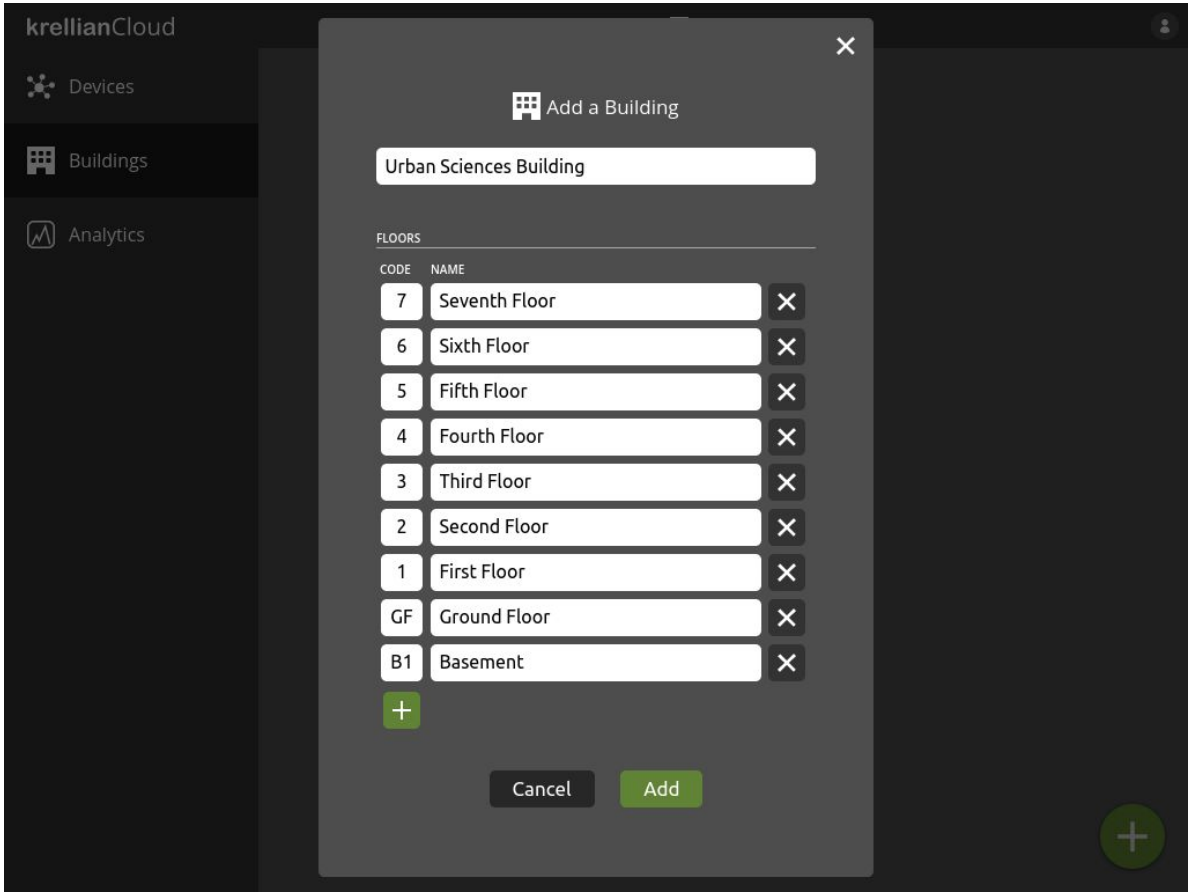
View Device


krellianCloud
Dimmable Color Light
Devices
Buildings
Analytics
Color
#729fcf
Color Temperature
2500
Color Mode
color
Brightness
0
On/Off

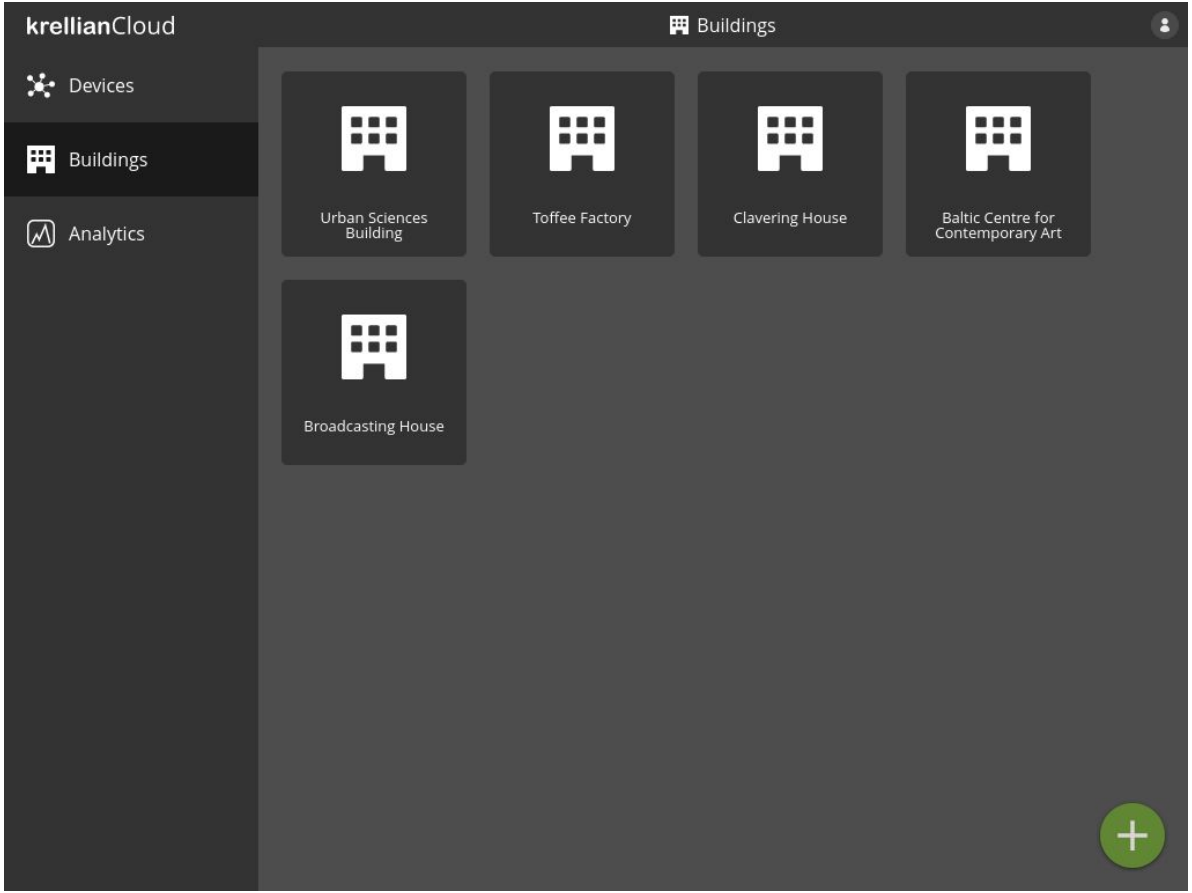
Buildings


krellianCloud
Buildings
Devices
Buildings
Analytics
Click + to add your first building

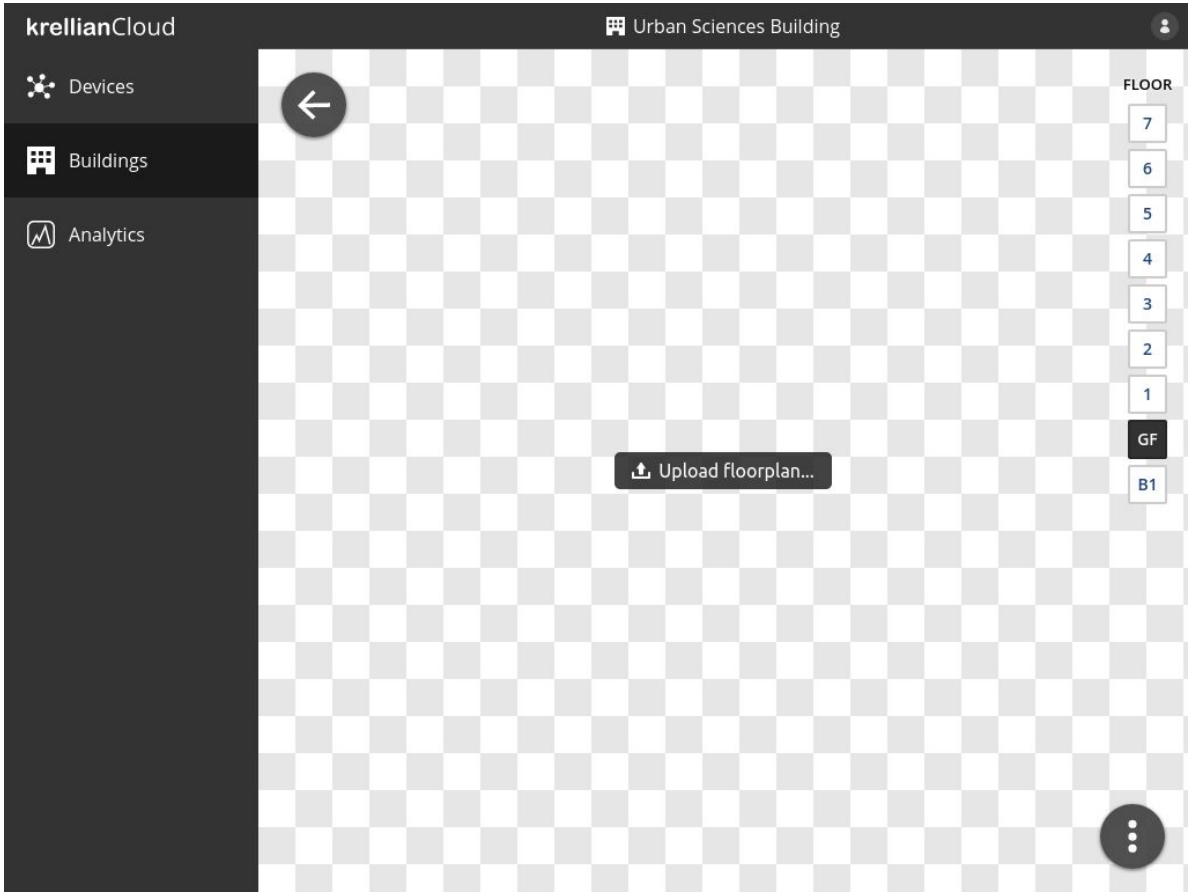
Add Building



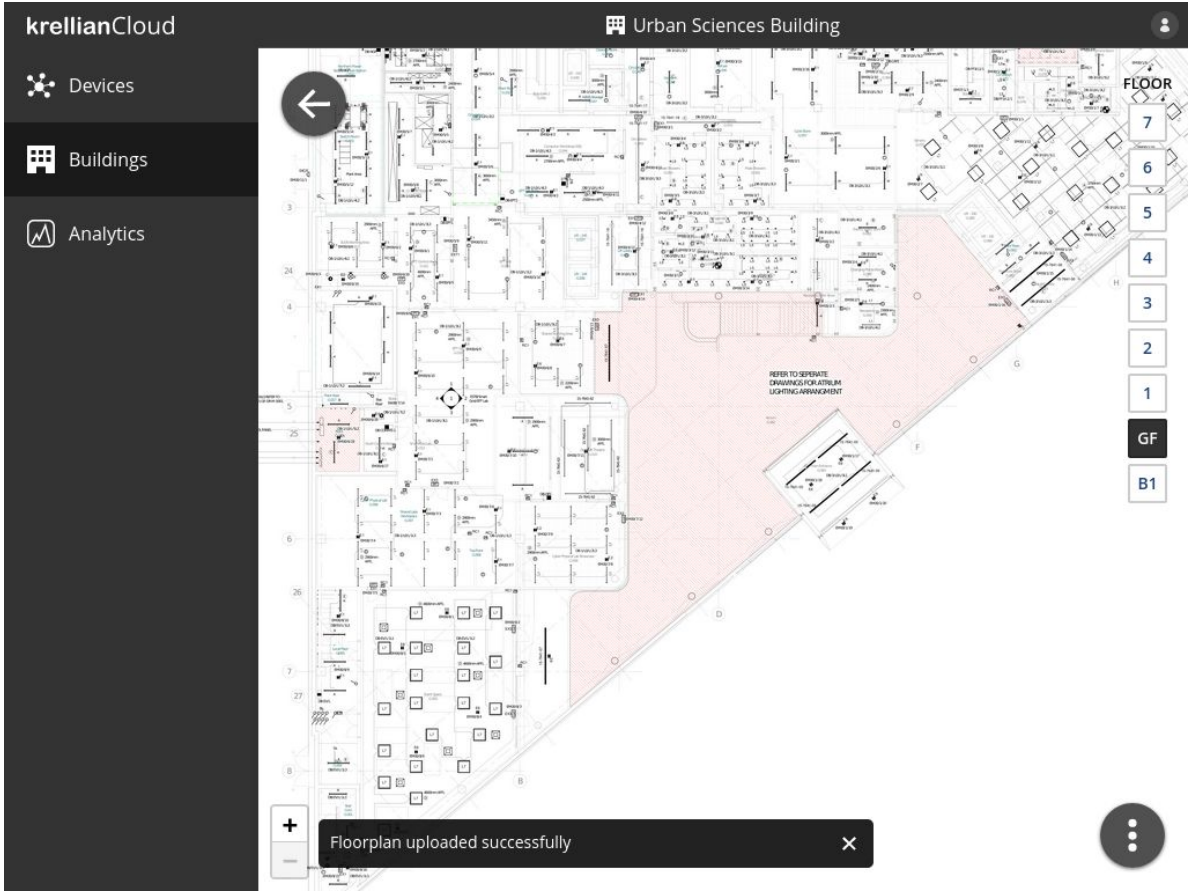
List Buildings



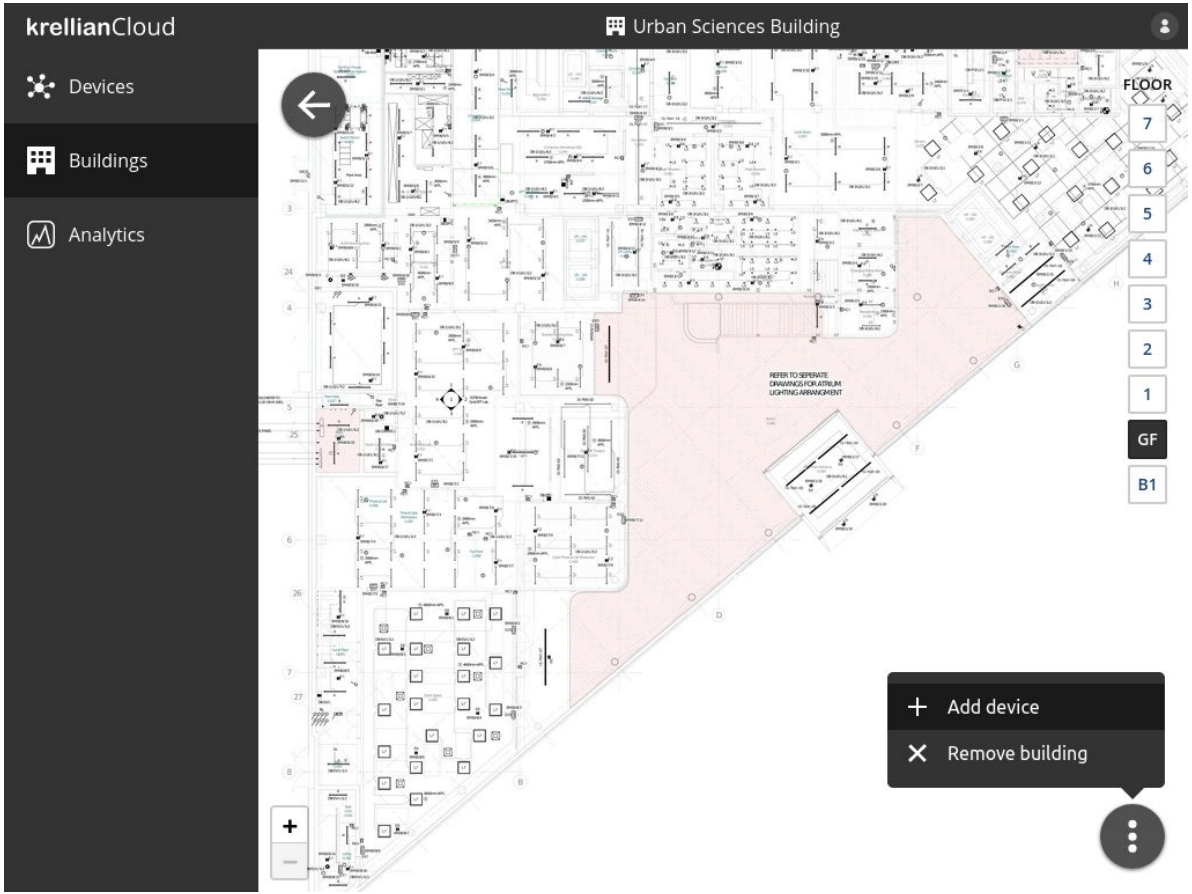
View Building



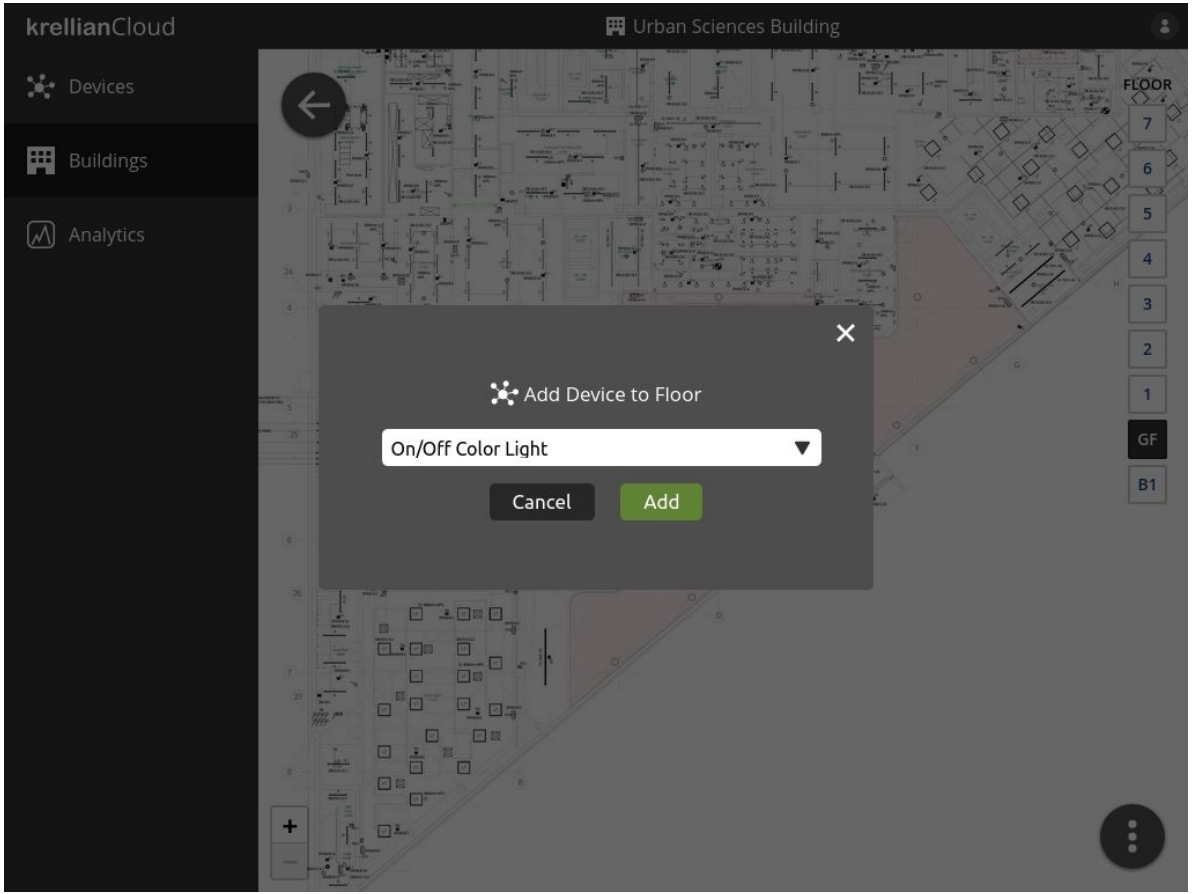
Upload Floorplan



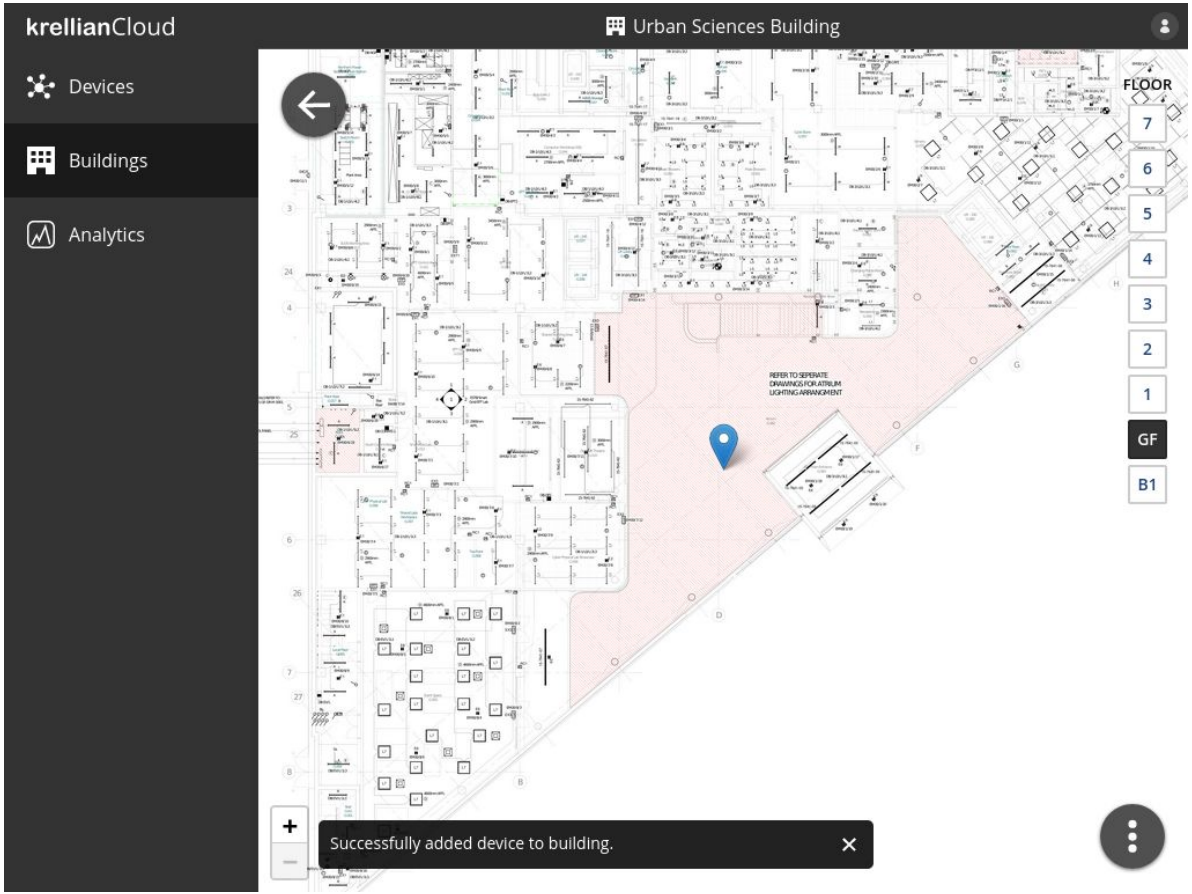
Floor Overflow Menu



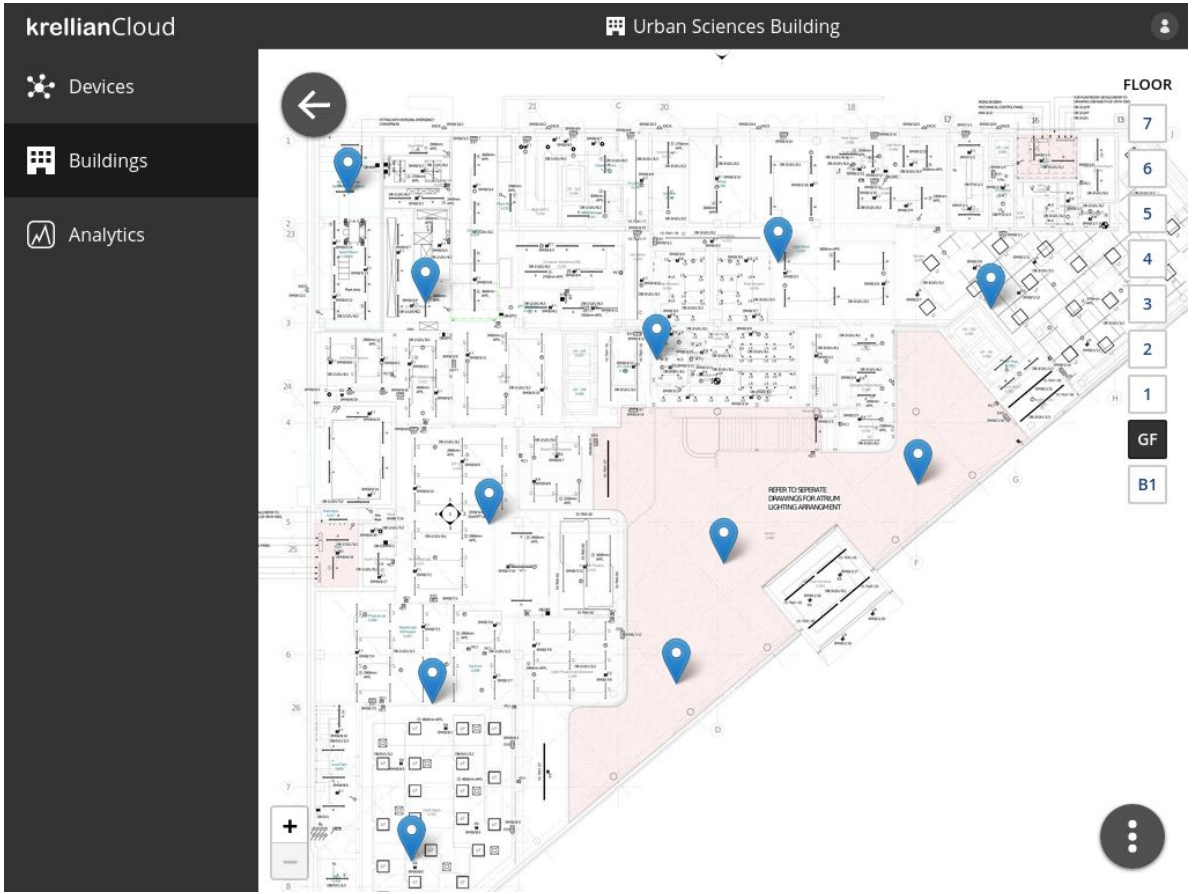
Add Device to Floor



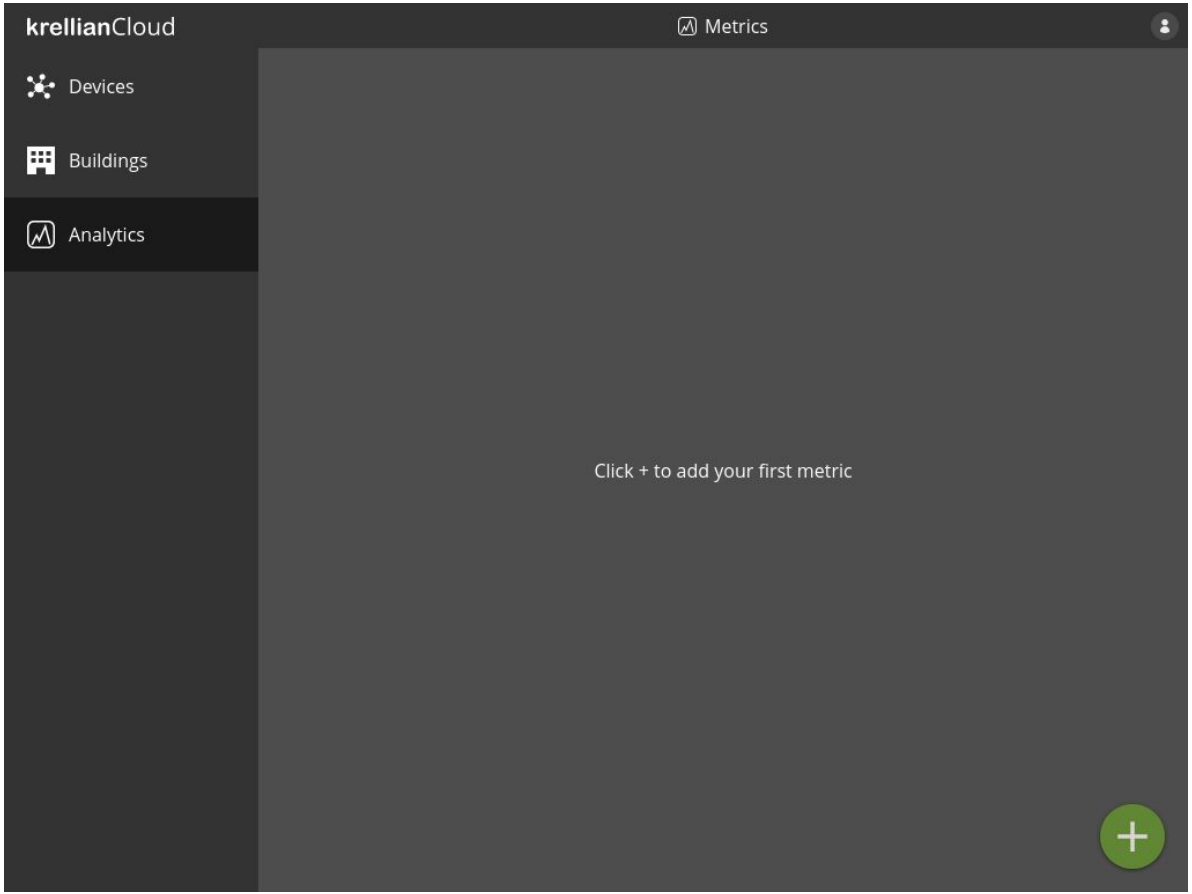
Device Added to Floor



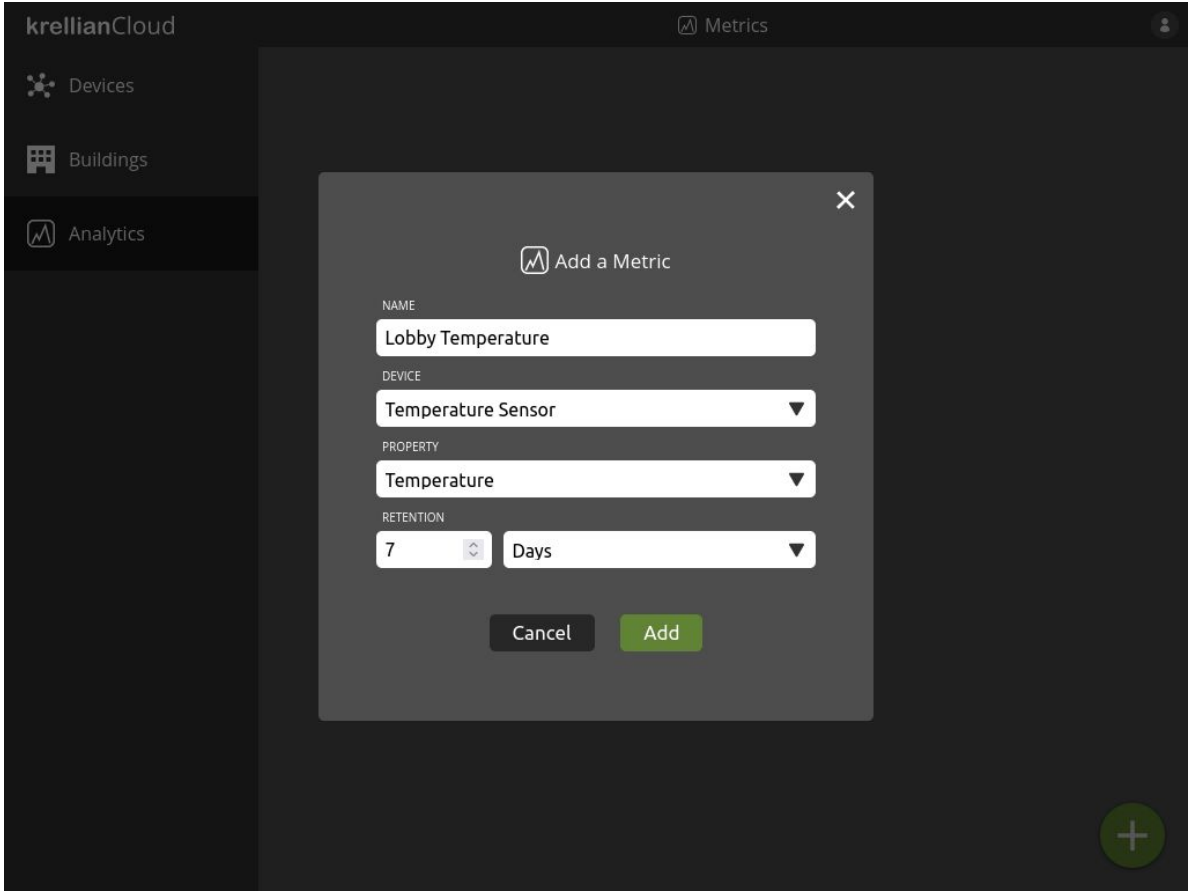
Devices on Floorplan



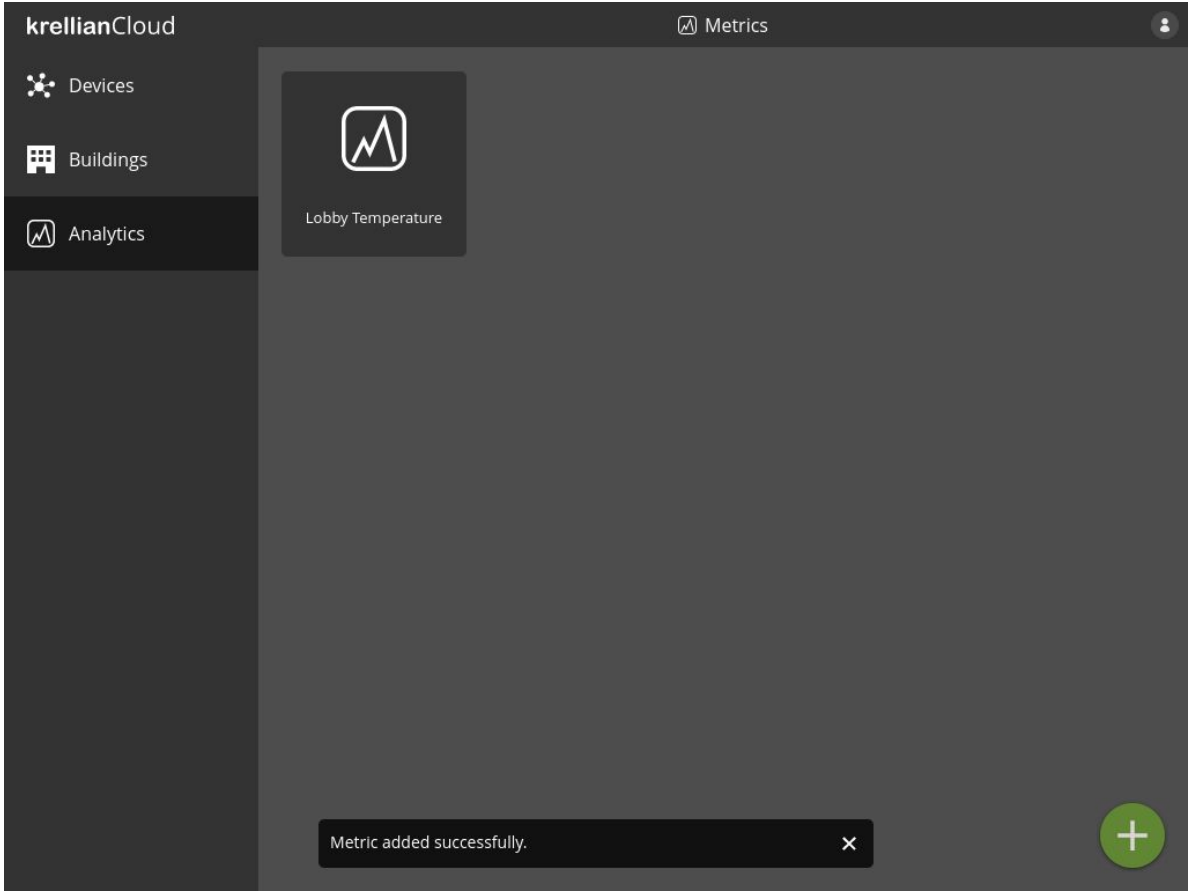
Analytics


krellianCloud
Metrics
Devices
Buildings
Analytics
Click + to add your first metric

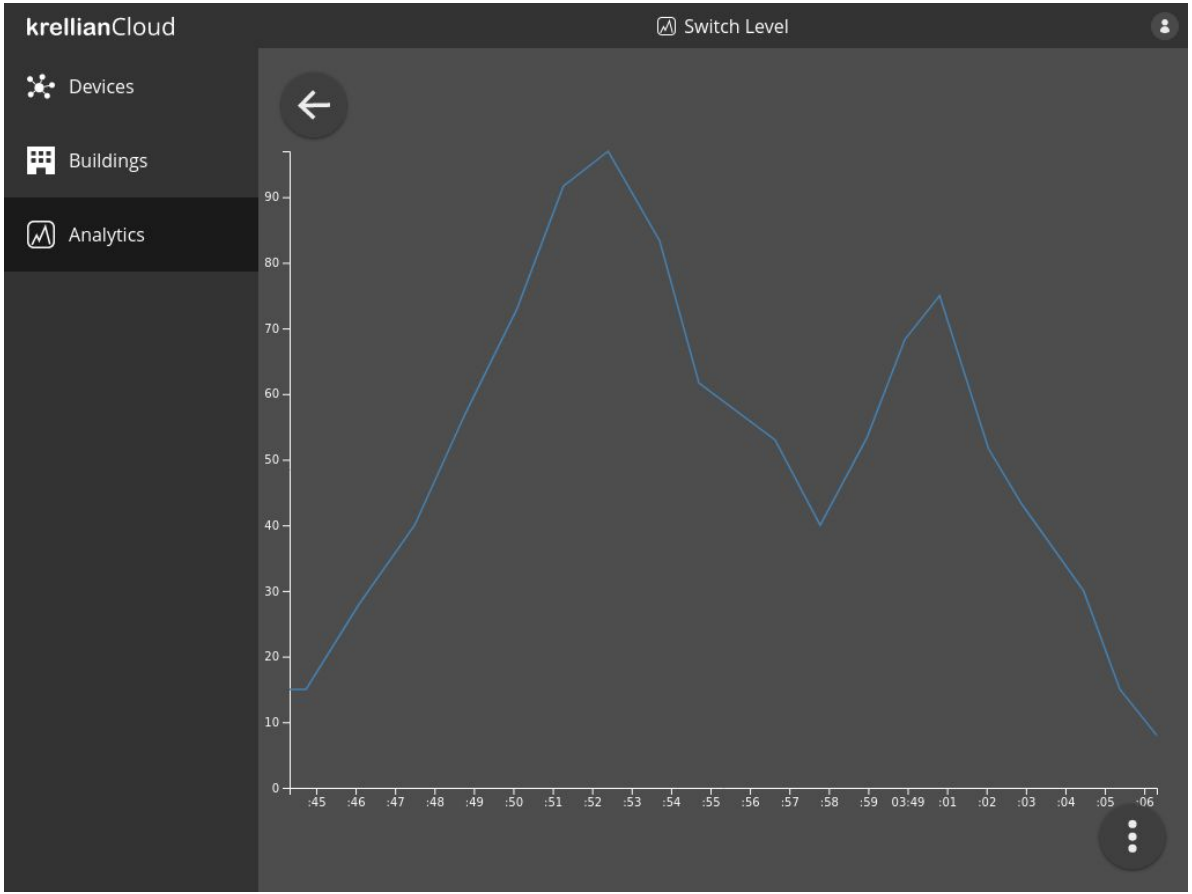
Add Metric


krellianCloud
Metrics
Devices
Buildings
Analytics
Add a Metric
NAME
Lobby Temperature
DEVICE
Temperature Sensor
PROPERTY
Temperature
RETENTION
7
Days
Cancel
Add

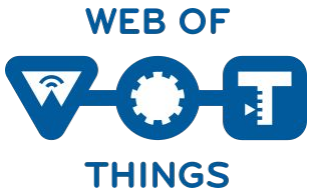
Metric Added



View Metric


krellianCloud
Switch Level
Devices
Buildings
Analytics
90
80
70
60
50
40
30
20
10
0
:45
:46
:47
:48
:49
:50
:51
:52
:53
:54
:55
:56
:57
:58
:59
03:49
:01
:02
:03
:04
:05
:06

W3C Standards Compliance



- ✔ WoT Thing Description 1.1 Consumer
- ✔ WoT Discovery 1.0 Thing Description Directory
- ✔ WoT Profiles 1.0 Consumer
  - ✔ HTTP Basic Profile
  - ✔ HTTP SSE Profile

Lessons Learnt
&
Next Steps

Lessons Learnt

1. *The Web of Things is a powerful tool for consolidating multi-vendor building management systems into a standardised interface that can be consumed by web services*

Lessons Learnt

2. *Neither SSE nor Webhooks scale well enough for this use case*

Webhooks

- A design pattern rather than a standard
- Reverses client-server roles
  - Thing as HTTP client (and server)
  - Consumer as HTTP server (and client)
- New HTTP request/TCP socket for each event
- No built-in rate-limiting mechanism
- Can accidentally DDoS your own service

Conclusion: Good for listening to low frequency events from a large number of devices

Server-Sent Events

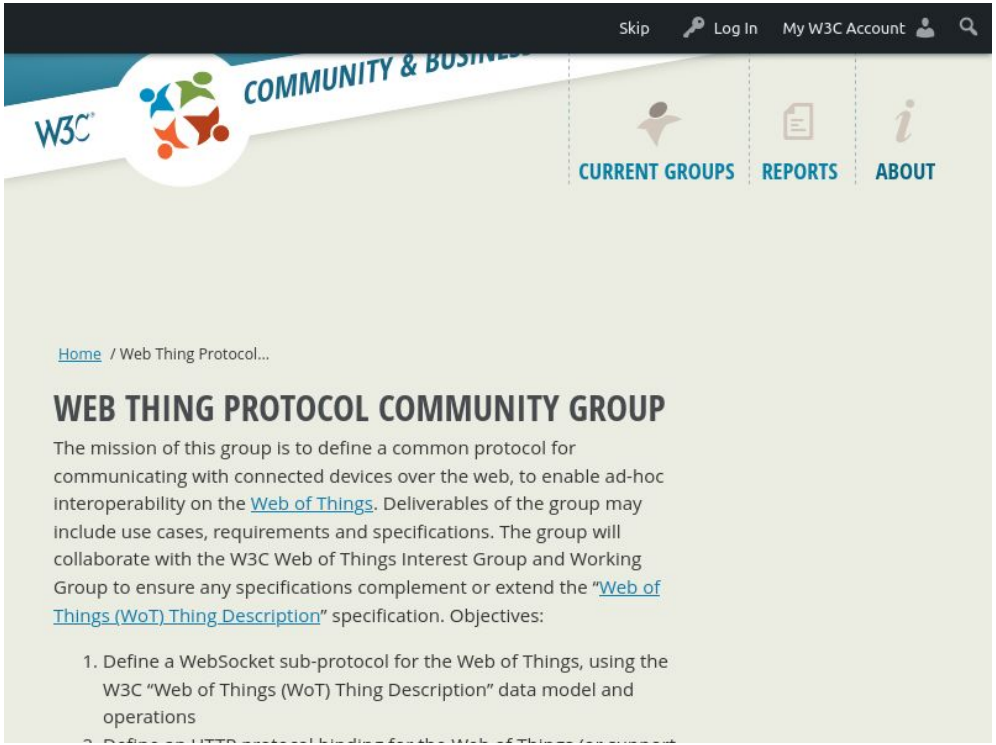
- Existing W3C/WHATWG standard
- Upgraded HTTP connection
- Uni-directional
- Requires keeping a separate TCP socket open for each affordance
- Limitations on the number of simultaneous connections that can be kept open

Conclusion: Good for listening to high frequency events from a small number of devices

WebSockets

- Existing W3C/WHATWG standard
- Bi-directional (can be used for all operation types, not just observing/subscribing)
- Can share a single TCP connection between multiple affordances and multiple Things
- Requires defining a sub-protocol
- Refinements needed to Thing Description specification?
    - Use a single endpoint for all operations
    - Re-use an open connection across interactions

Web Thing Protocol Community Group



https://www.w3.org/community/web-thing-protocol/

Web Thing Protocol WebSocket Sub-protocol

Strawman Proposal

Web Thing Protocol

WebSocket Sub-protocol

Strawman Proposal 16 November 2023

This version:
https://docs.google.com/document/d/1KWv-aQfMgsqBFg0v4rVqzcVvzzisC7y4X4CMUYGc8rE

Editor:
Ben Francis (Krellian)

Feedback:
GitHub w3c/web-thing-protocol (pull requests, new issue, open issues)
public-web-thing-protocol@w3.org with subject line [web-thing-protocol-requirements] *… message topic …* (archives)

https://docs.google.com/document/d/1KWv-aQfMgsqBFg0v4rVqzcVvzzisC7y4X4CMUYGc8rE

Lessons Learnt

3. *There's no way to automatically keep a Thing Description in a Thing Description Directory in sync with its original source*

Keeping TDs Updated in a Directory

1. When adding a Thing Description to a Directory from a URL, no record of the original URL
2. There are `expires` and `ttl` members of registration metadata, but it's not clear what should happen once a TD expires

Lessons Learnt

4. *JSONPath is a limited tool for searching Thing Description Directories*

JSONPath Search

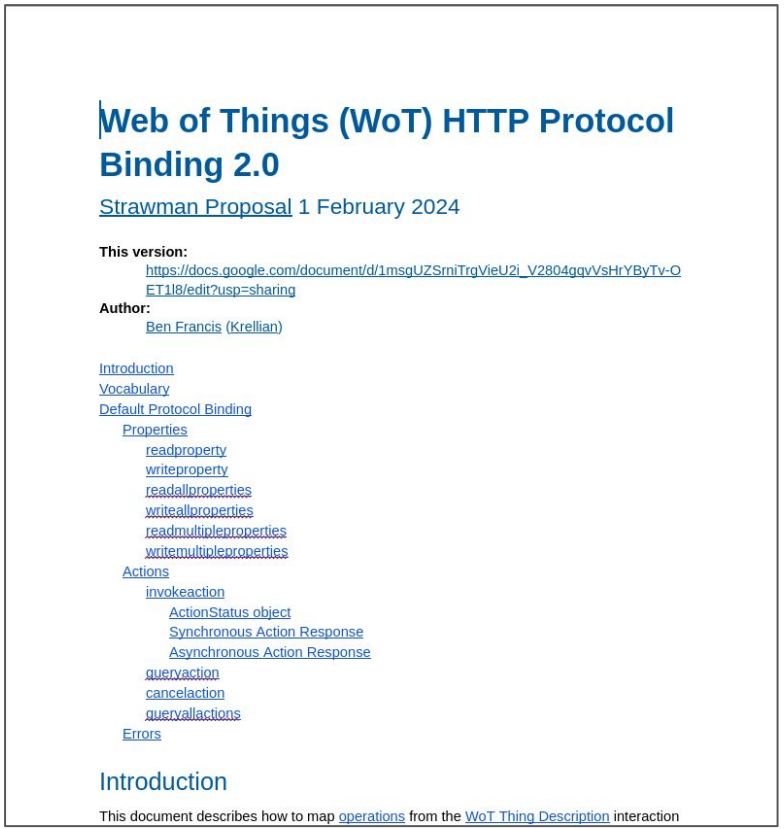
Currently missing:

1. Standardised filter options - e.g. filter by the presence of a value in an array
2. JSON-LD support - expanding prefixes from “compact IRIs”

Lessons Learnt

5. *Profiles and Binding Templates could work better together*

Profiles 2.0 - Strawman Proposal



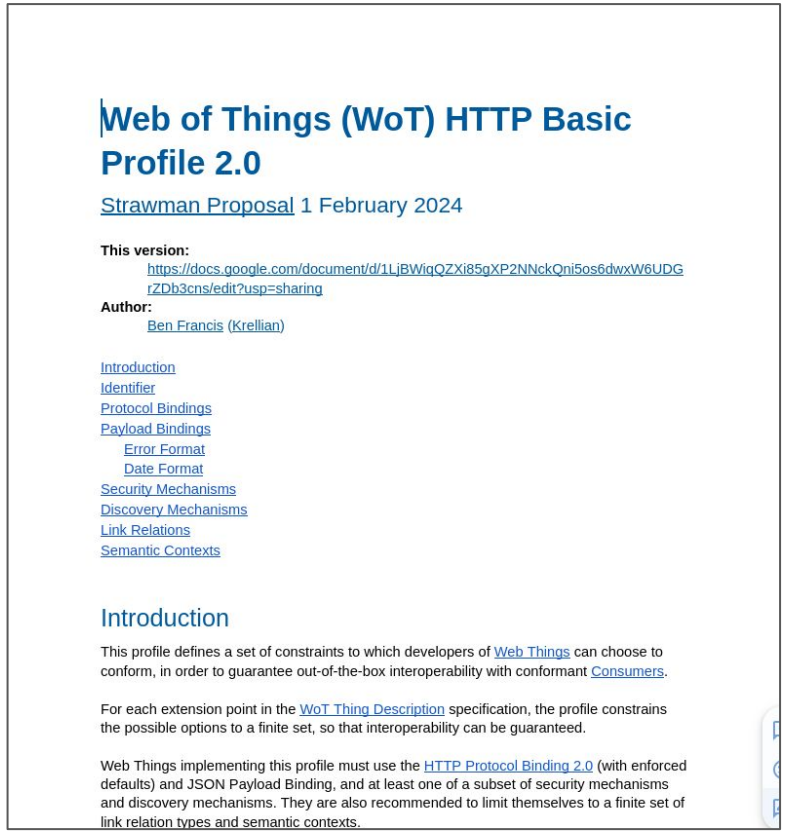
Web of Things (WoT) HTTP Protocol Binding 2.0

Strawman Proposal 1 February 2024

This version:
https://docs.google.com/document/d/1msgUZSrniTrgVieU2i_V2804gqvVsHrYByTv-OET1l8/edit?usp=sharing
Author:
Ben Francis (Krellian)

Introduction

This document describes how to map operations from the WoT Thing Description interaction



Web of Things (WoT) HTTP Basic Profile 2.0

Strawman Proposal 1 February 2024

This version:
https://docs.google.com/document/d/1LjBWiqQZXi85gXP2NNckQni5os6dwxW6UDGrZDb3cns/edit?usp=sharing
Author:
Ben Francis (Krellian)

Introduction

This profile defines a set of constraints to which developers of Web Things can choose to conform, in order to guarantee out-of-the-box interoperability with conformant Consumers.

For each extension point in the WoT Thing Description specification, the profile constrains the possible options to a finite set, so that interoperability can be guaranteed.

Web Things implementing this profile must use the HTTP Protocol Binding 2.0 (with enforced defaults) and JSON Payload Binding, and at least one of a subset of security mechanisms and discovery mechanisms. They are also recommended to limit themselves to a finite set of link relation types and semantic contexts.

https://lists.w3.org/Archives/Public/public-wot-wg/2024Feb/0000.html

Next Steps

WebThings Gateway

- Full OAuth2 implementation
- W3C compliant Directory Service API
- W3C compliant mDNS/DNS-SD discovery
- Fix various standards compliance bugs
- Implement standardised Web Thing Protocol WebSocket sub-protocol
- Production quality distribution of WebThings Gateway built on Ubuntu Core
    - Gateway application containerised in a snap package with strict security confinement
    - A custom OS image bundling the snap with Ubuntu Core
    - Automatic transactional OTA updates for the app *and* the underlying OS

krellianCloud

- Full OAuth2 implementation
- Directory Service API Consumer
- Implement standardised Web Thing Protocol WebSocket sub-protocol
- Richer data visualisations (e.g. heat maps, date ranges)
- Richer UI for Things
- Control as well as monitor devices
- Use machine learning to automatically identify potential optimisations

krellianHub

Consolidate multi-vendor building management systems into a single standardised interface

Open

Reliable

Secure

krellian.com/hub

krellianConsulting

Web of Things Consulting

As the **UK's leading experts on the Web of Things**, Krellian can help you understand the latest W3C WoT standards, and implement them in your project, product or service.

Web Thing

Thing Directory

WoT Consumer

krellian.com/consulting

Questions?

krellian.com