



krellianTM

Smart Building Solutions
built on WebThings®

Ben Francis
Founder

*Businesses are wasting money on
underutilised and inefficient buildings*

59%

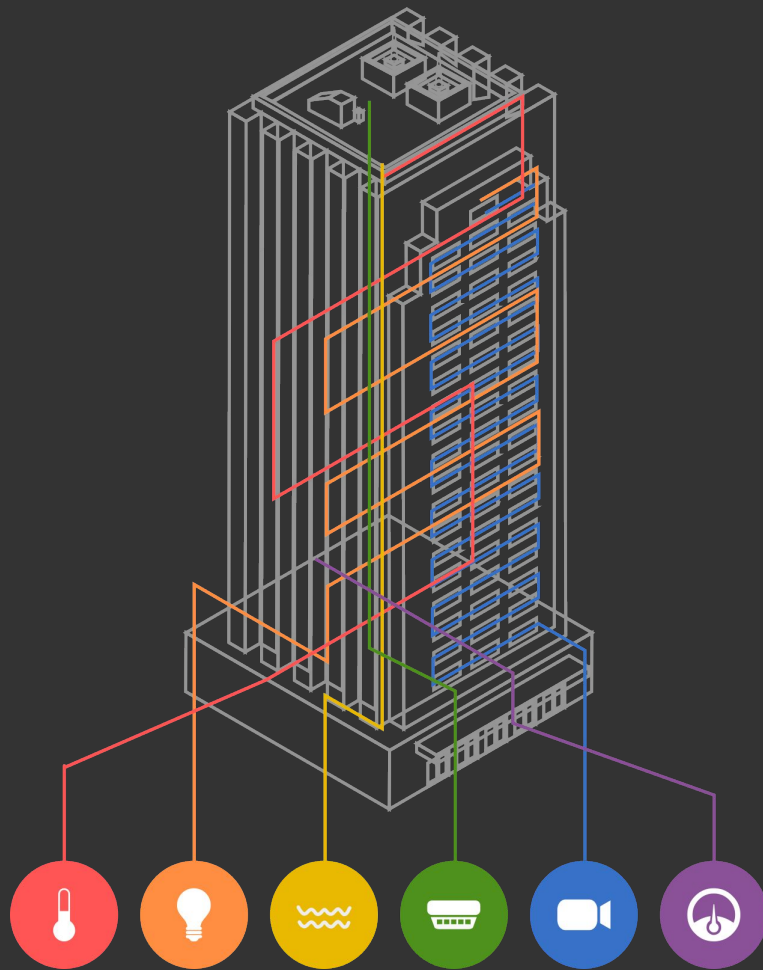
Reduced office
space requirements

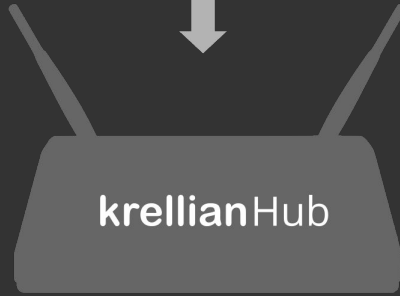
292%

Increase in energy
prices

£6bn

Potential energy
efficiency savings

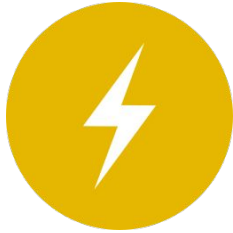




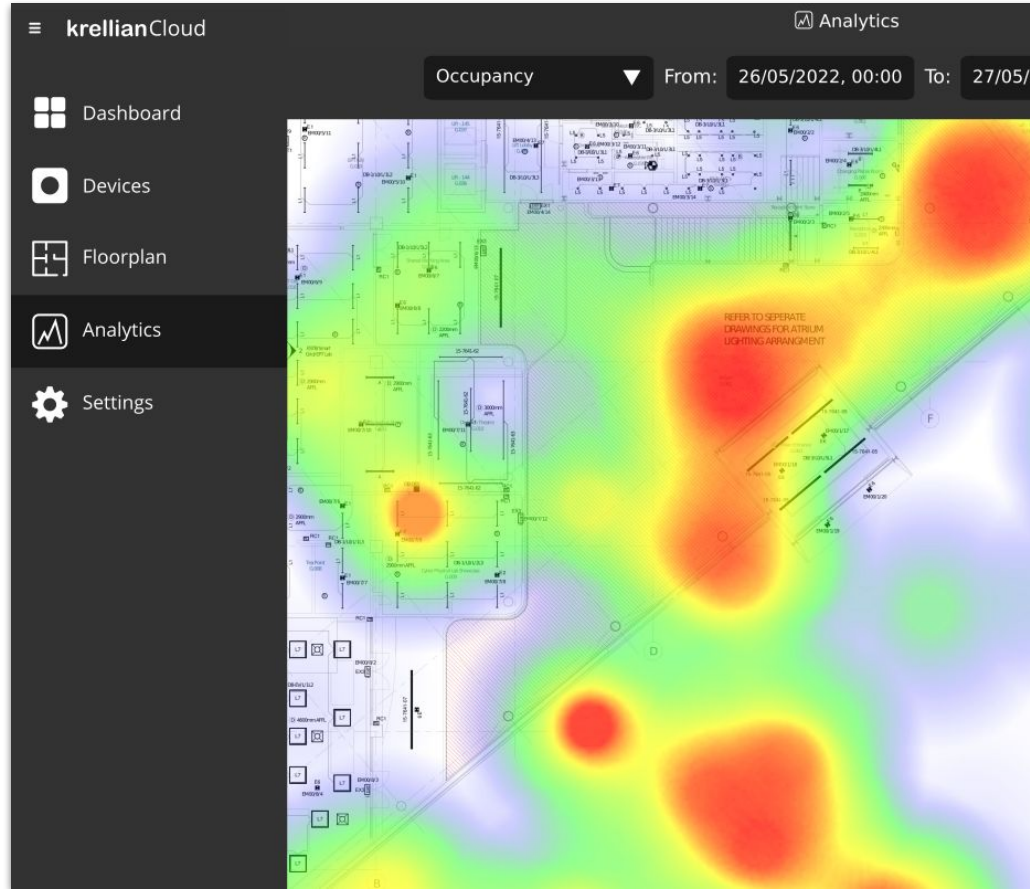
*Helps **facilities managers**
meet their **net zero** targets
whilst **saving money***



Space
Utilisation



Energy
Consumption



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



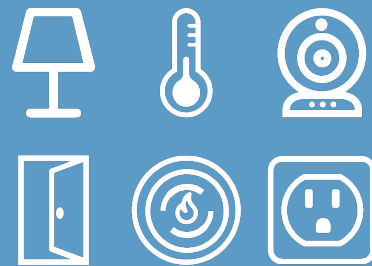


An open platform for monitoring and controlling devices over the web.



WebThings Gateway

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

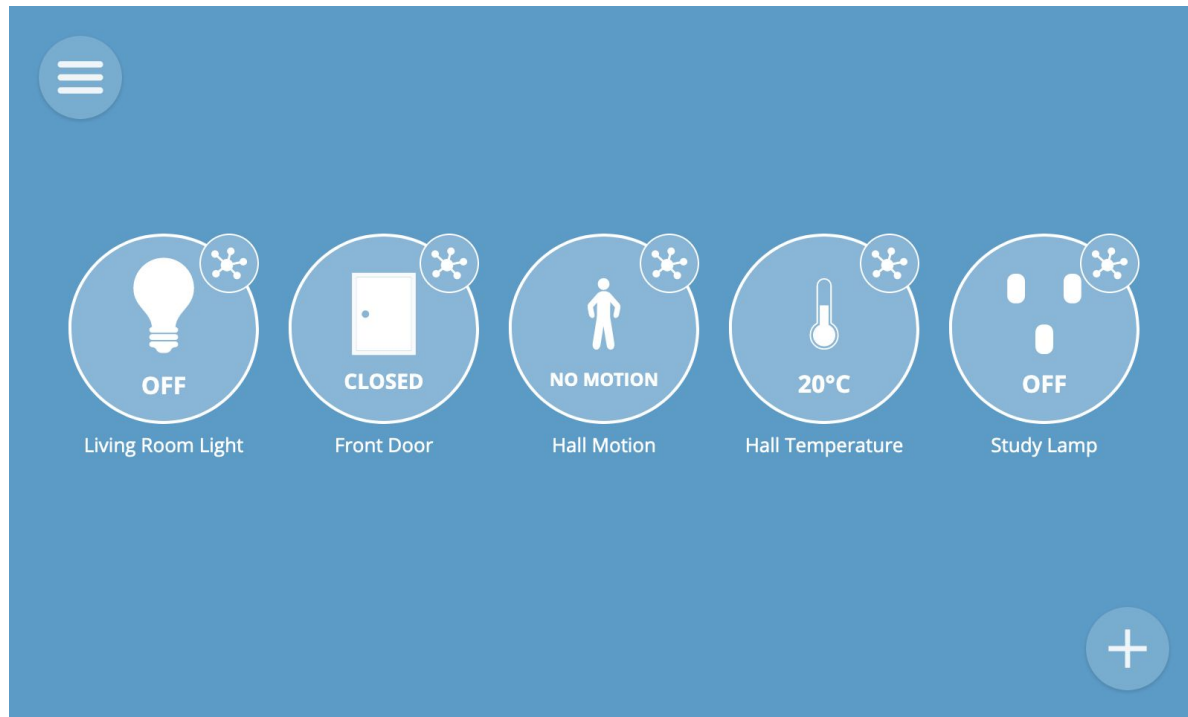


WebThings Framework

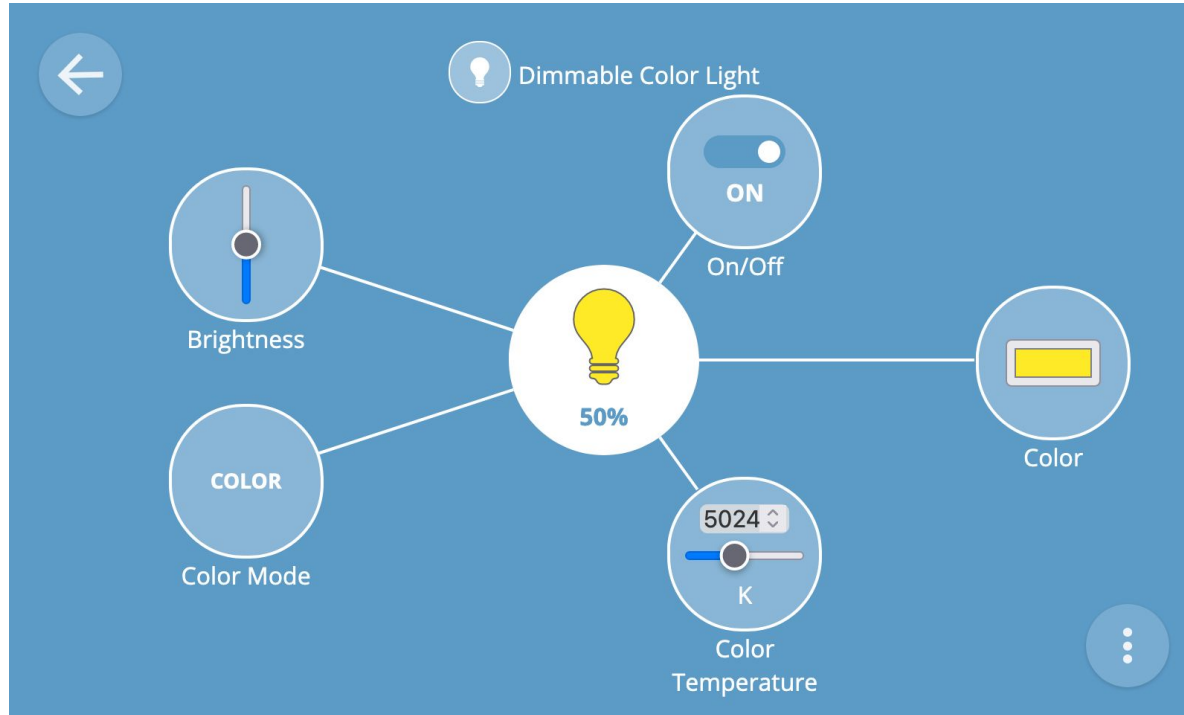
A collection of reusable software components to help developers build their own web things

webthings.io

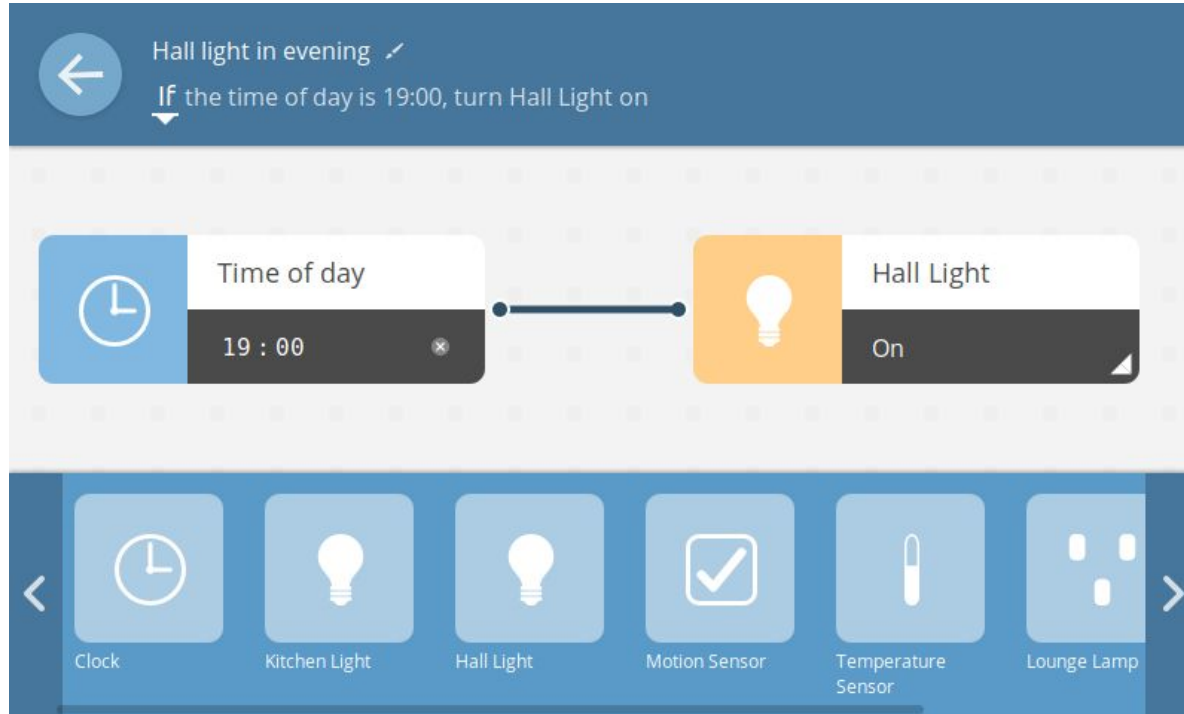
Things



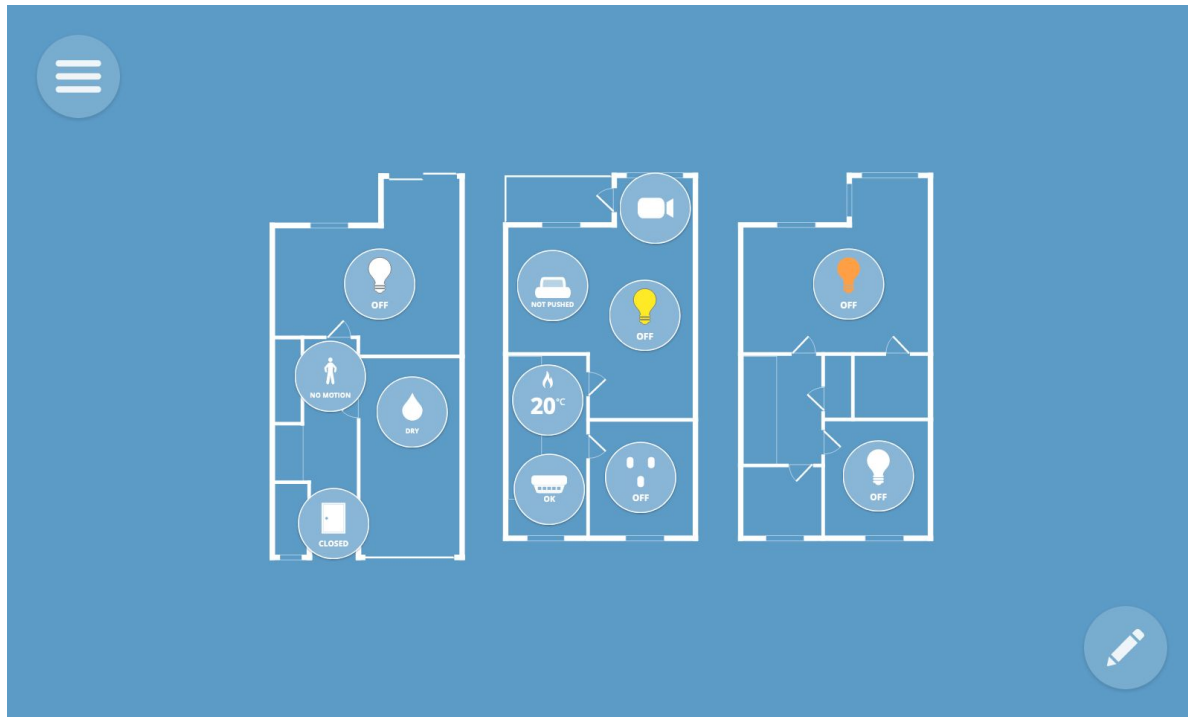
Thing



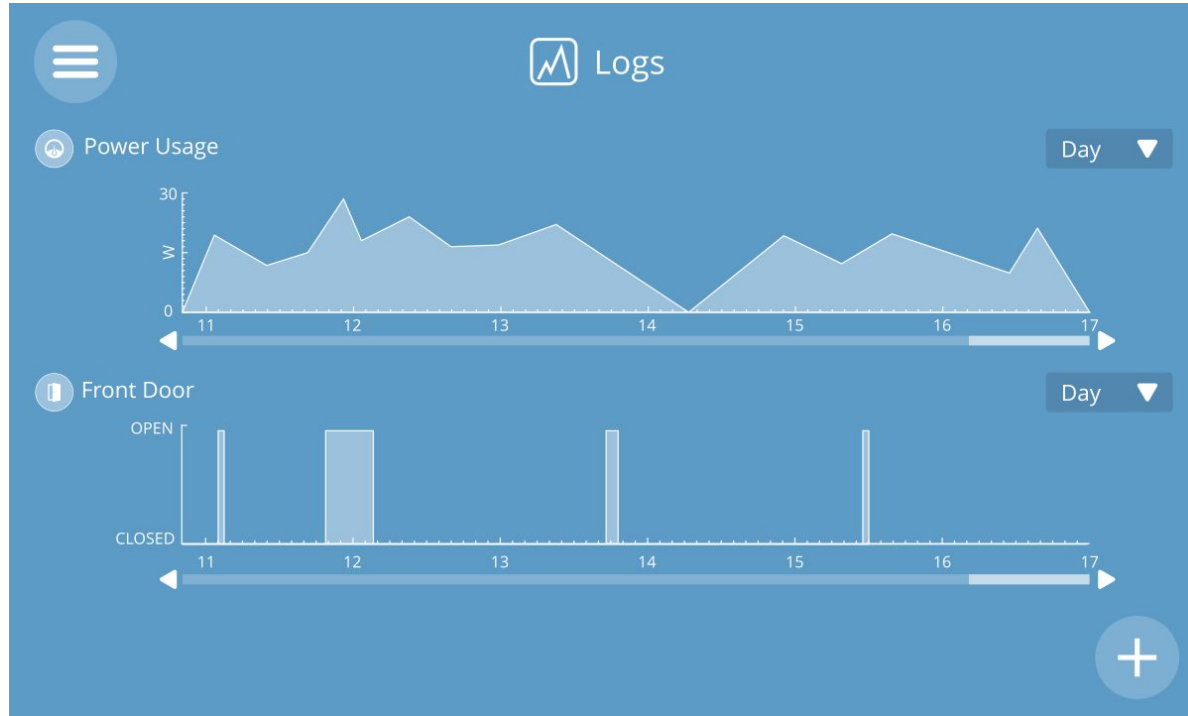
Rules



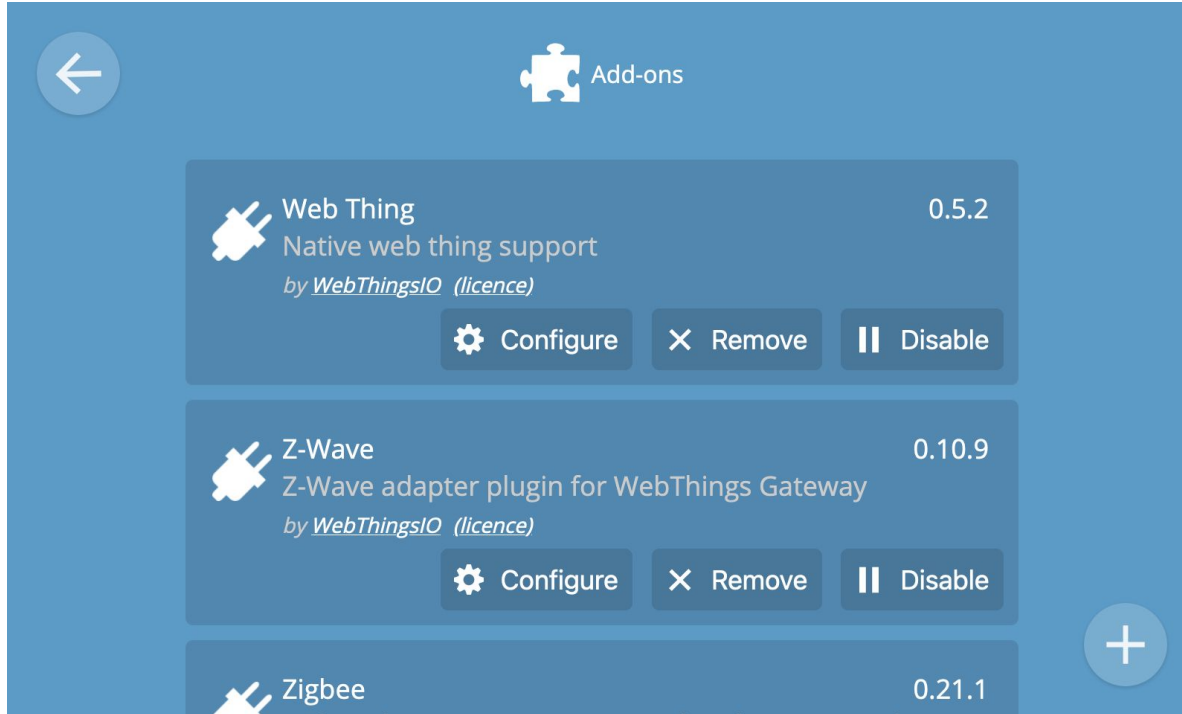
Floorplan



Logging



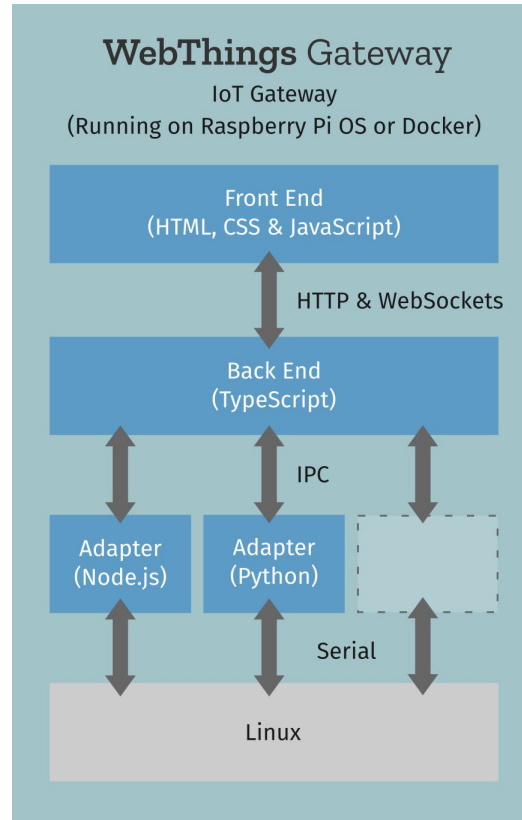
Add-ons



The screenshot displays the 'Add-ons' management interface. At the top, there is a back arrow on the left and a puzzle piece icon with the text 'Add-ons' on the right. Below this, a list of add-ons is shown, each with a plug icon, name, description, version, and control buttons. The add-ons listed are 'Web Thing' (version 0.5.2), 'Z-Wave' (version 0.10.9), and 'Zigbee' (version 0.21.1). Each entry has 'Configure', 'Remove', and 'Disable' buttons. A plus sign button is located at the bottom right.

Add-on Name	Description	Version	Configure	Remove	Disable
Web Thing	Native web thing support by WebThingsIO (licence)	0.5.2	⚙️	✖️	⏸️
Z-Wave	Z-Wave adapter plugin for WebThings Gateway by WebThingsIO (licence)	0.10.9	⚙️	✖️	⏸️
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

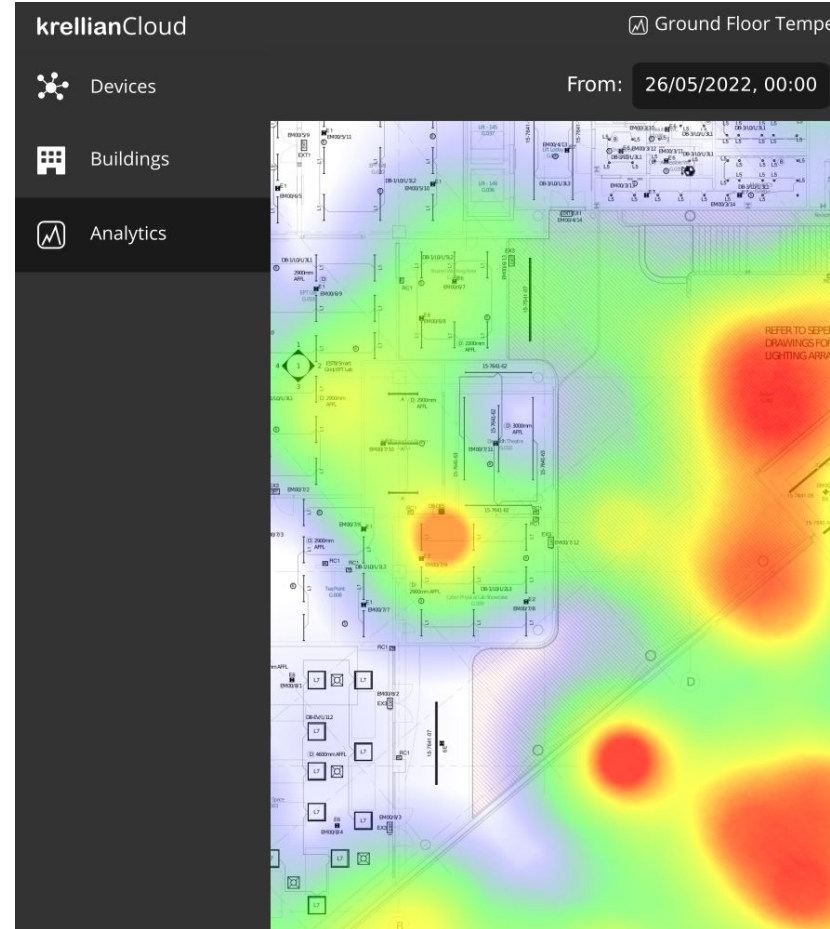


Energy

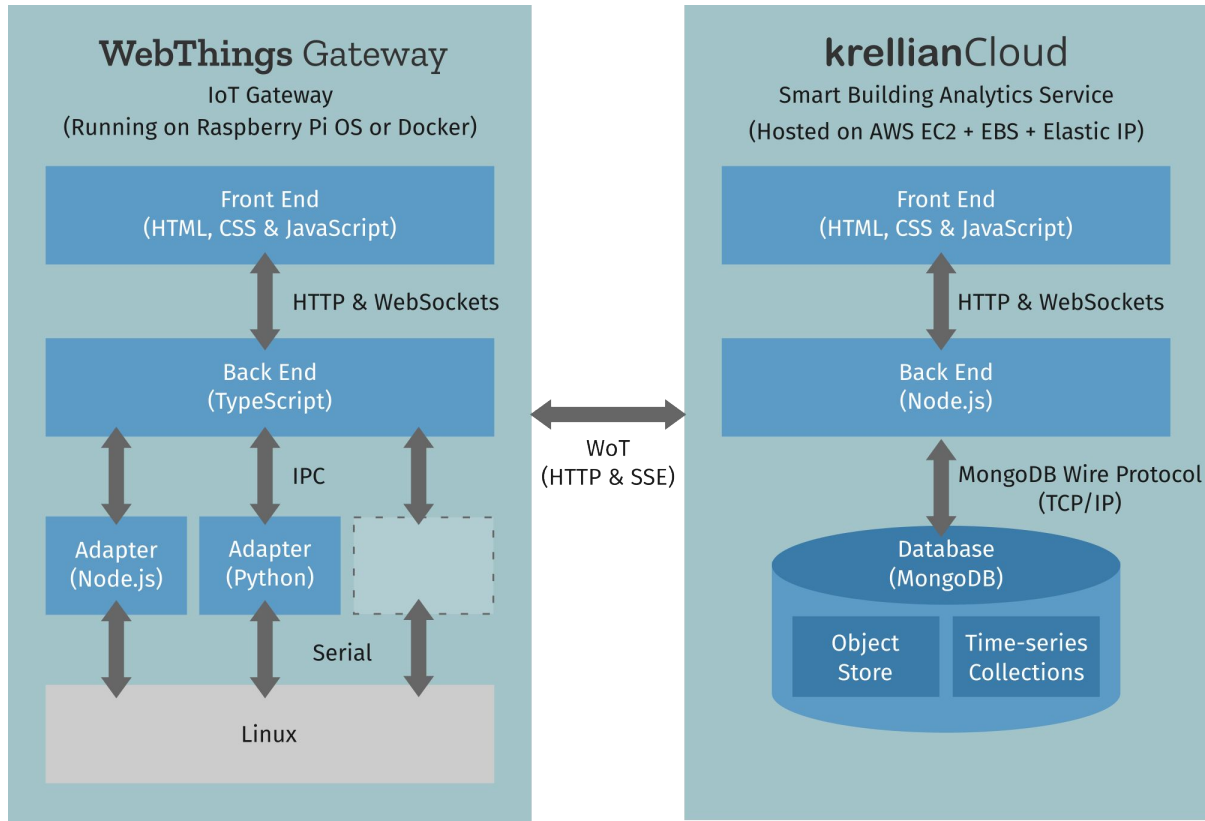


Safety

krellian.com/cloud



WebThings Gateway + krellianCloud



Sign Up

krellianCloud

Sign Up

First name

Last name

Email address

Password

Confirm password


☐ Subscribe to newsletter

Sign up

[Privacy Policy](#)

Log In

krellianCloud

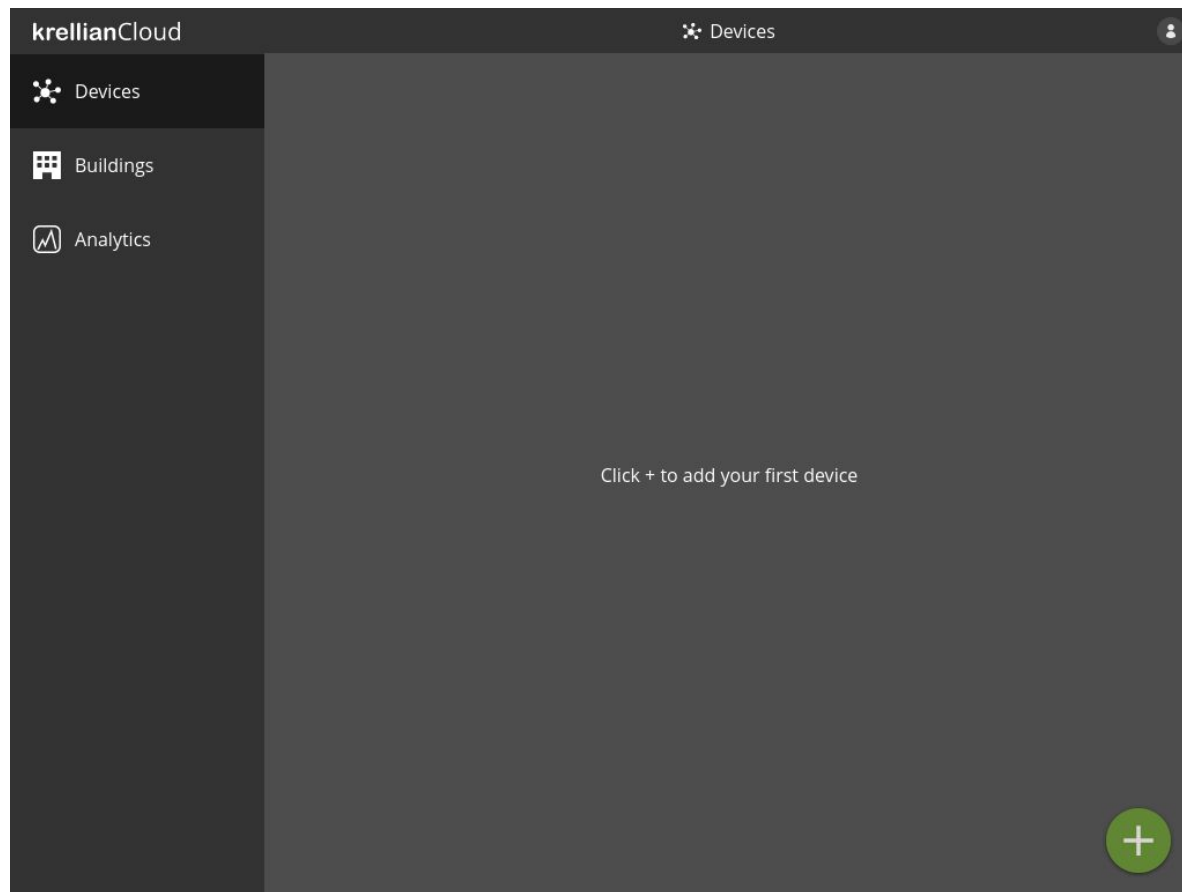


krellianCloud

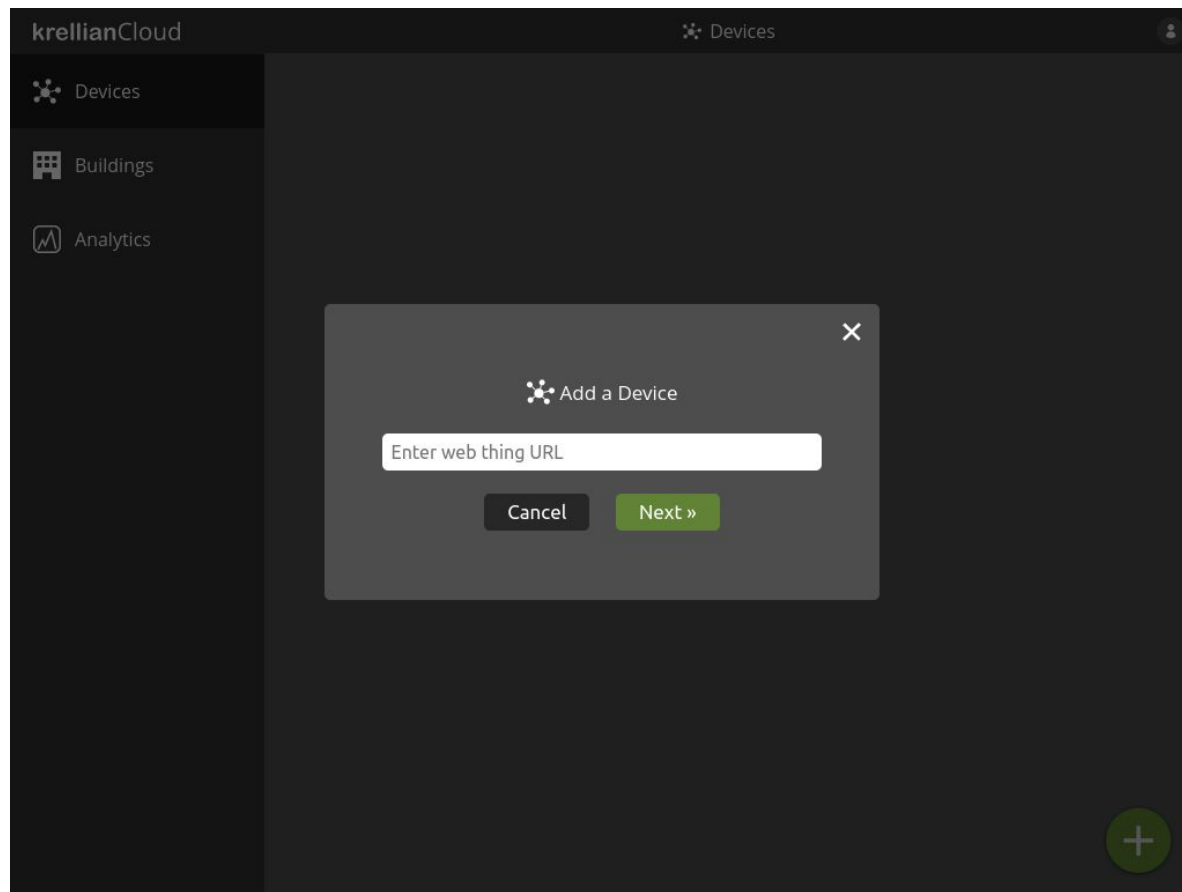
Log in

[Sign up](#)

Devices



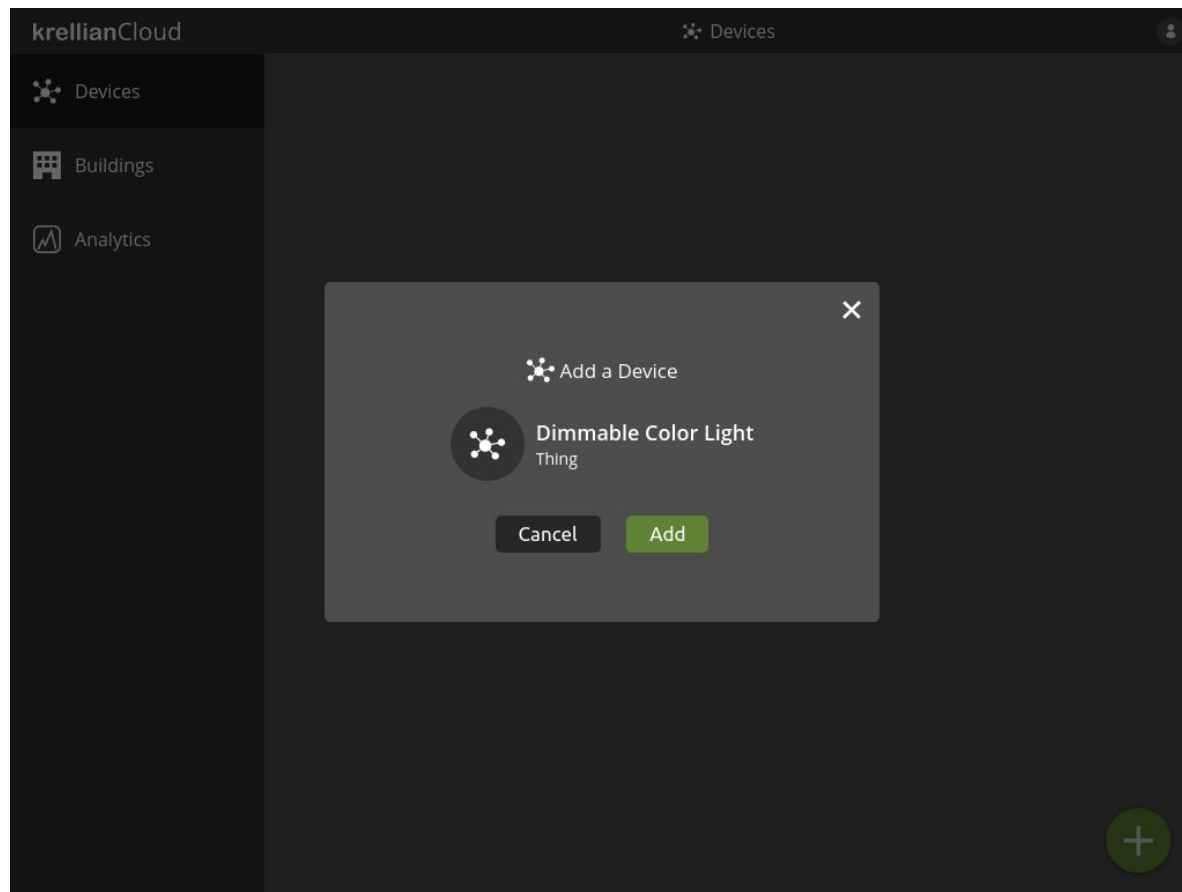
Add Device



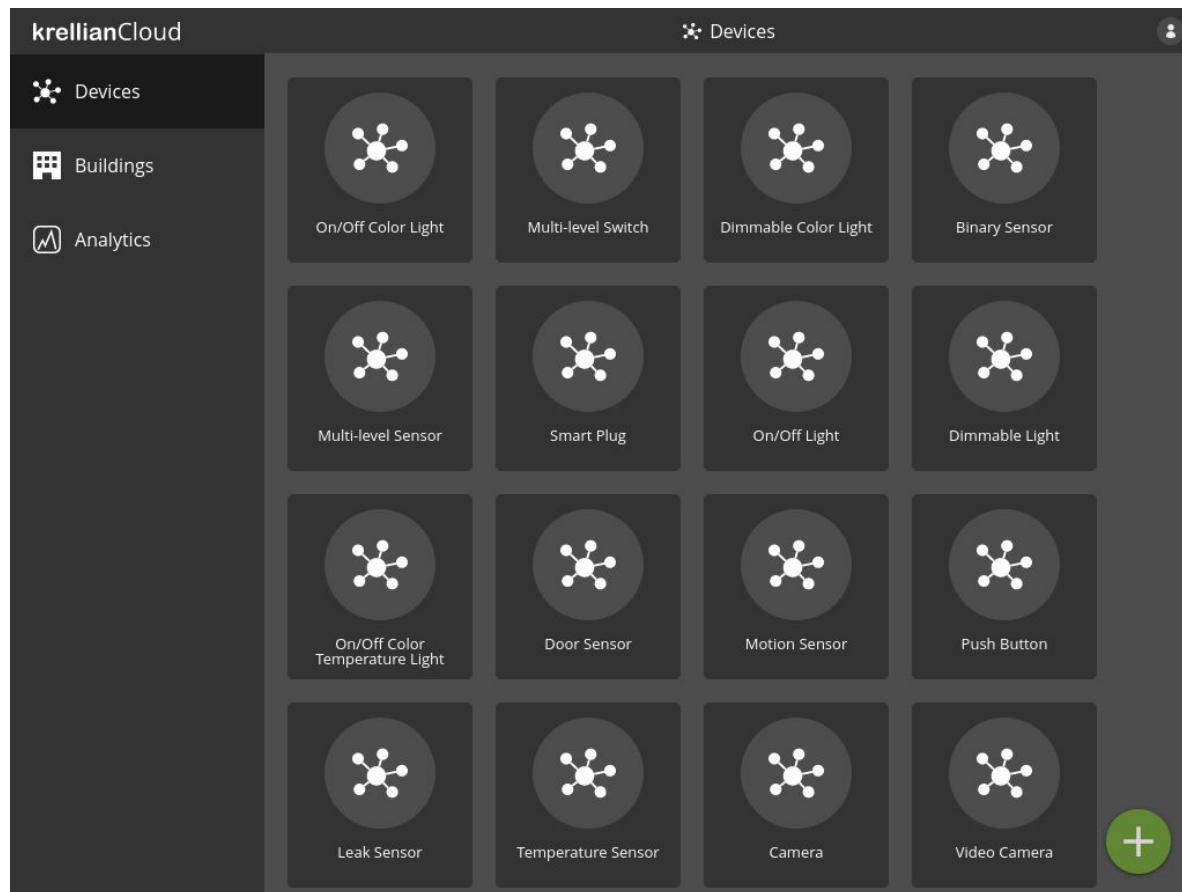
Authenticate Device

The screenshot shows the krellianCloud interface with a sidebar containing 'Devices', 'Buildings', and 'Analytics'. The main area displays a modal dialog titled 'Add a Device' with a close button (X) in the top right corner. The dialog contains two input fields: the first contains the URL 'https://tola4.webthings.io/things/virtual-things-2' and the second is labeled 'Bearer token'. Below the fields are two buttons: 'Cancel' and 'Next »'. At the bottom of the interface, a dark status bar displays the message 'Valid authentication token needed.' with a close button (X) on the right. A green circular button with a white plus sign is located in the bottom right corner of the interface.

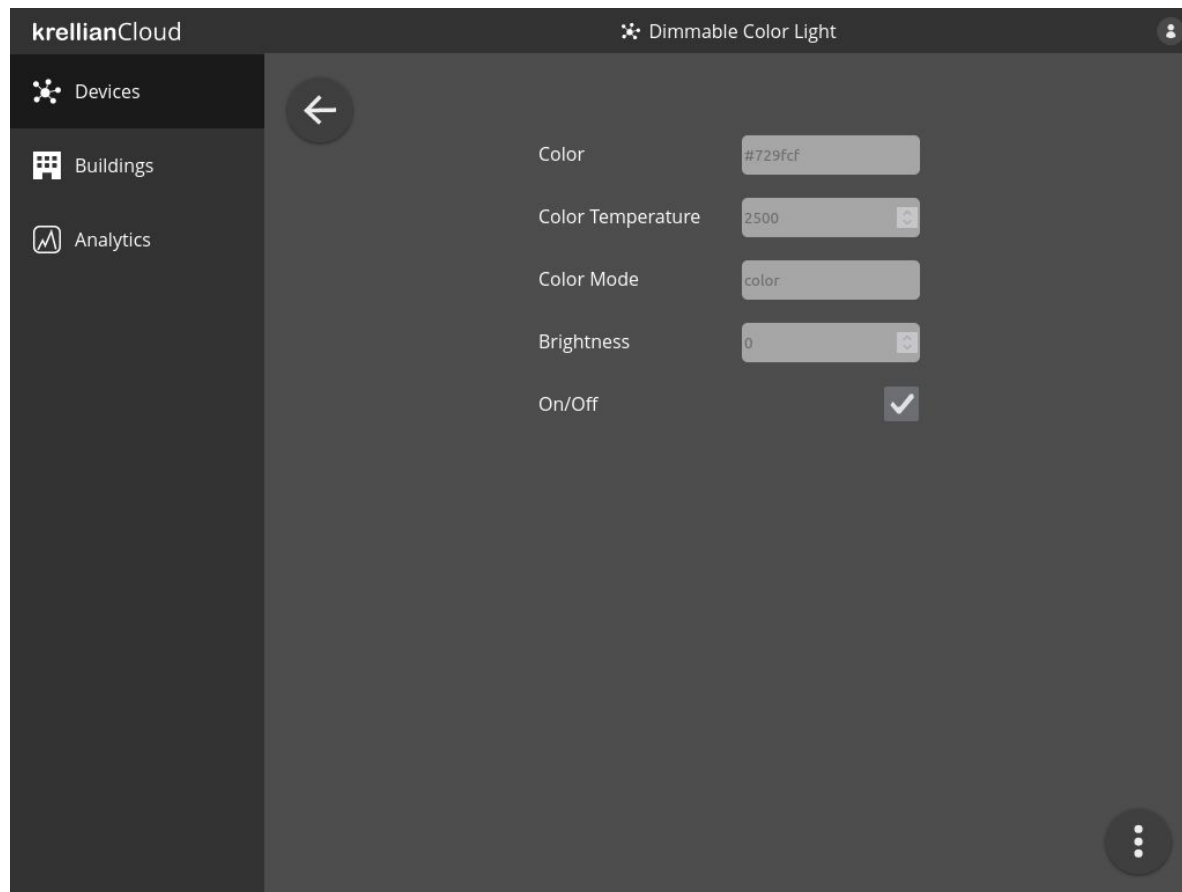
Preview Device



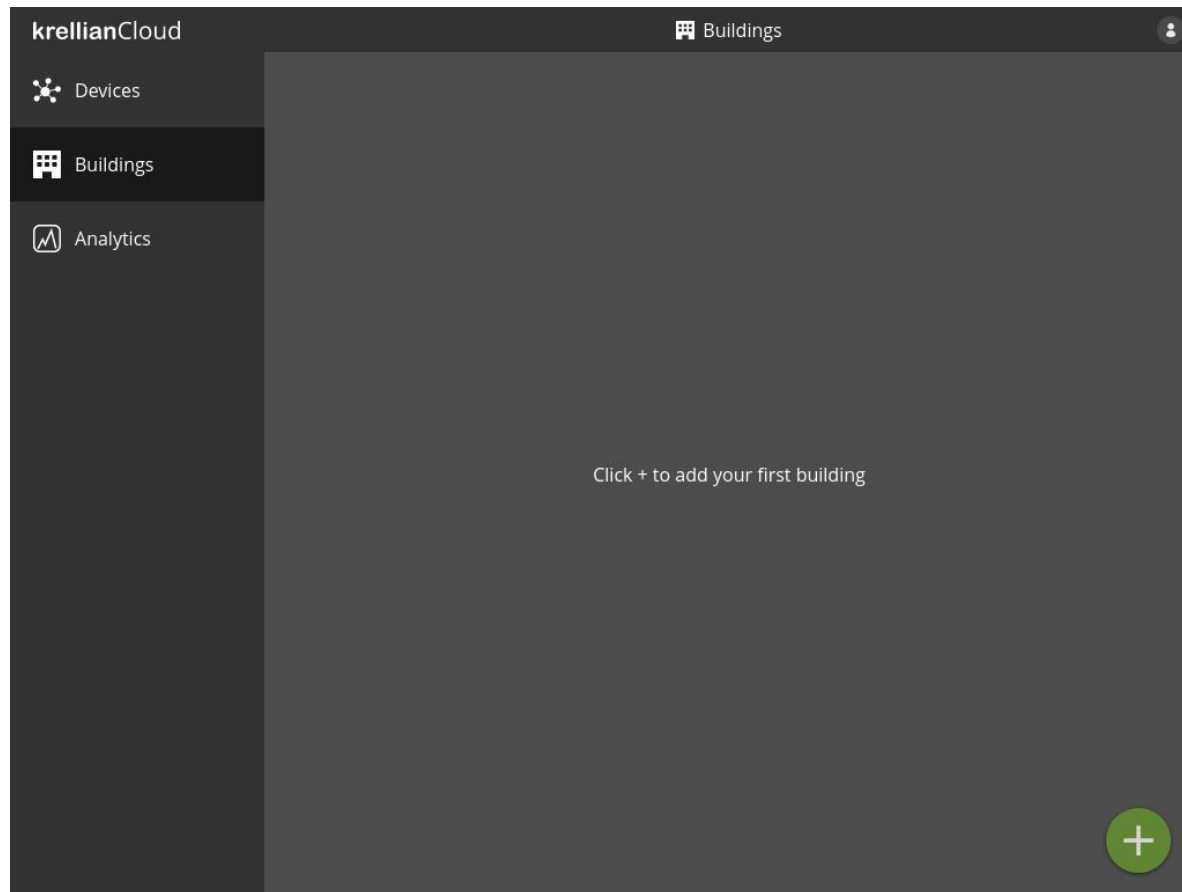
List Devices



View Device



Buildings



Add Building


krellianCloud

Devices

Buildings

Analytics

×

 Add a Building

FLOORS

CODE	NAME	
7	Seventh Floor	×
6	Sixth Floor	×
5	Fifth Floor	×
4	Fourth Floor	×
3	Third Floor	×
2	Second Floor	×
1	First Floor	×
GF	Ground Floor	×
B1	Basement	×

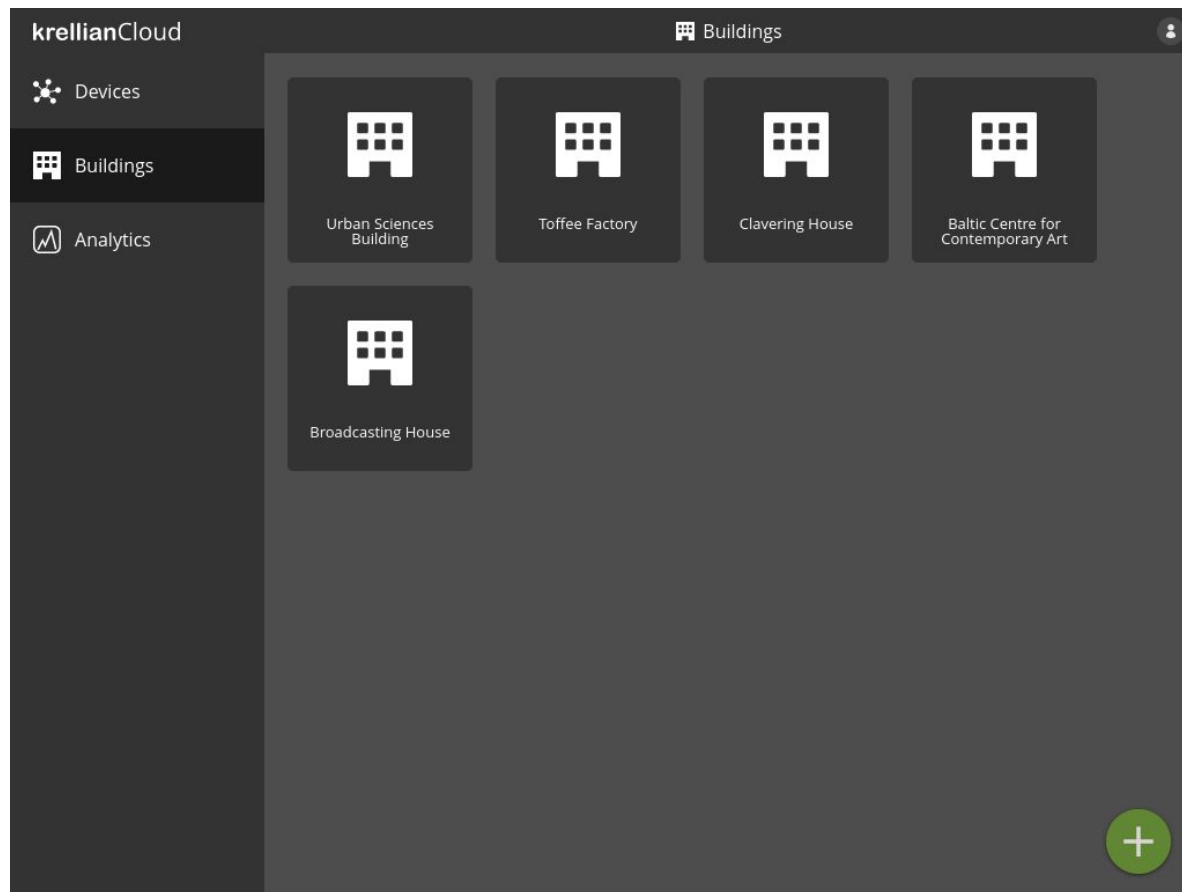
+

Cancel

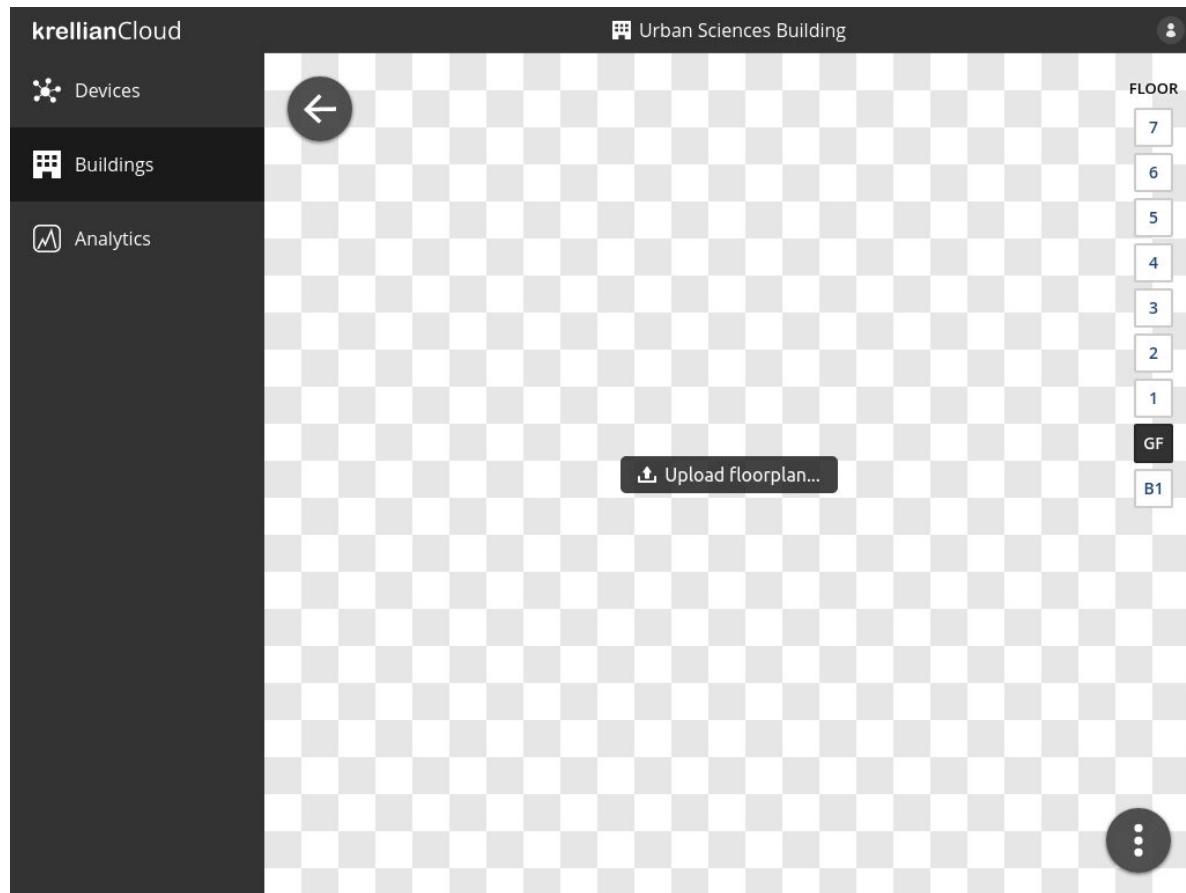
Add

+

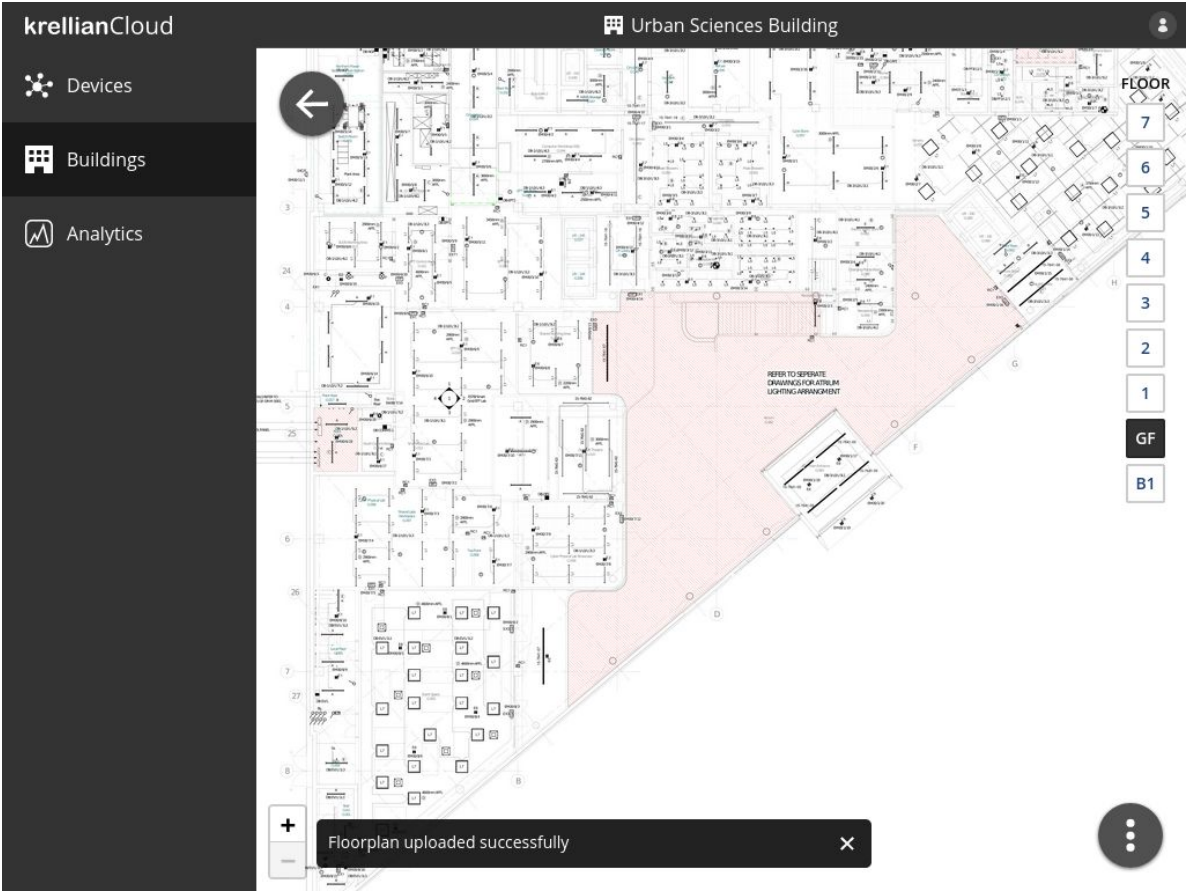
List Buildings



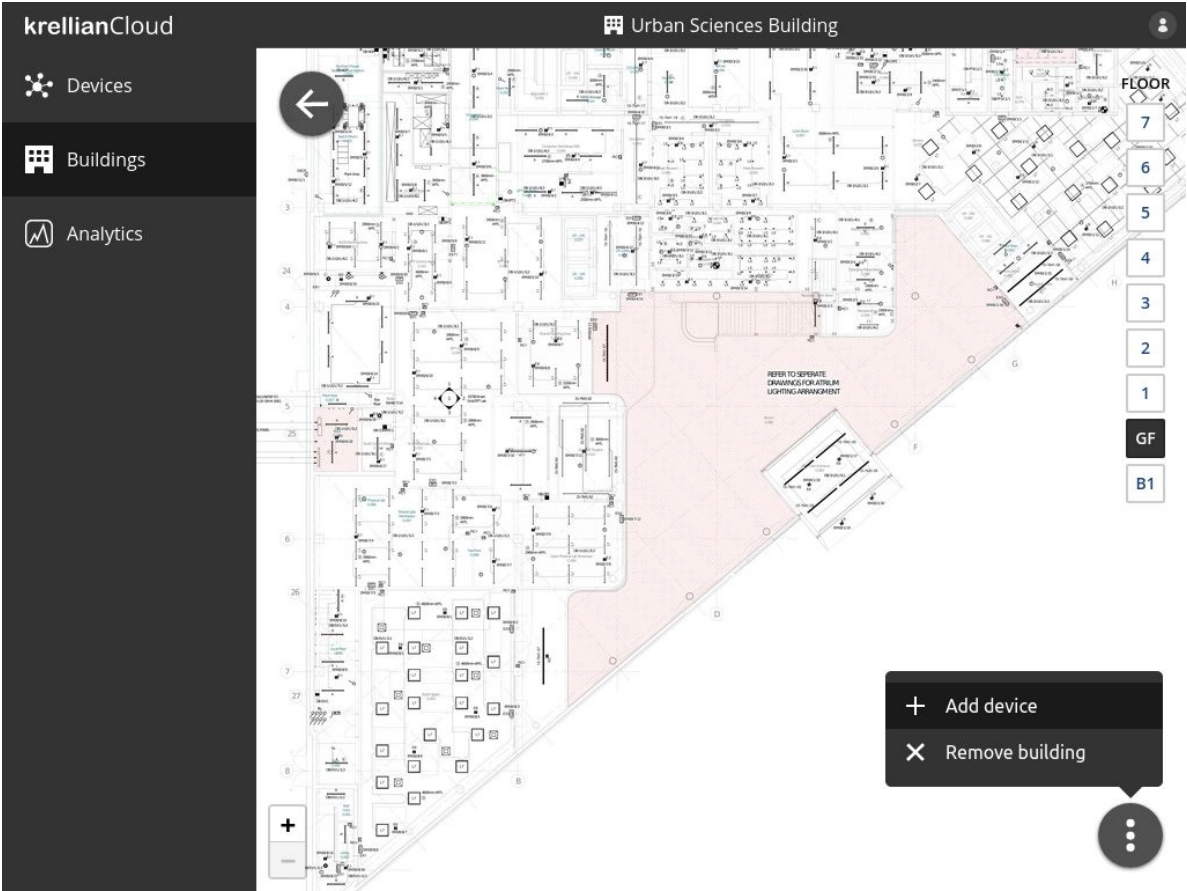
View Building



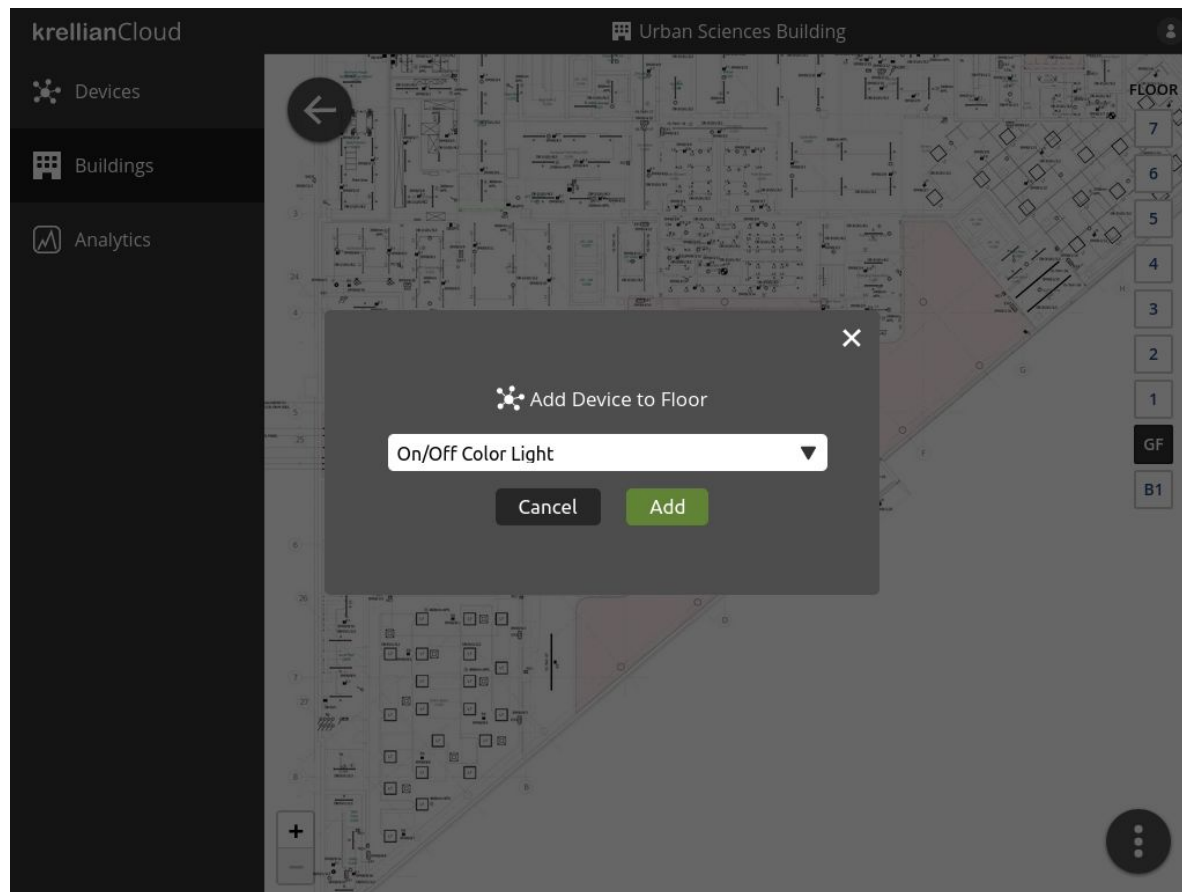
Upload Floorplan



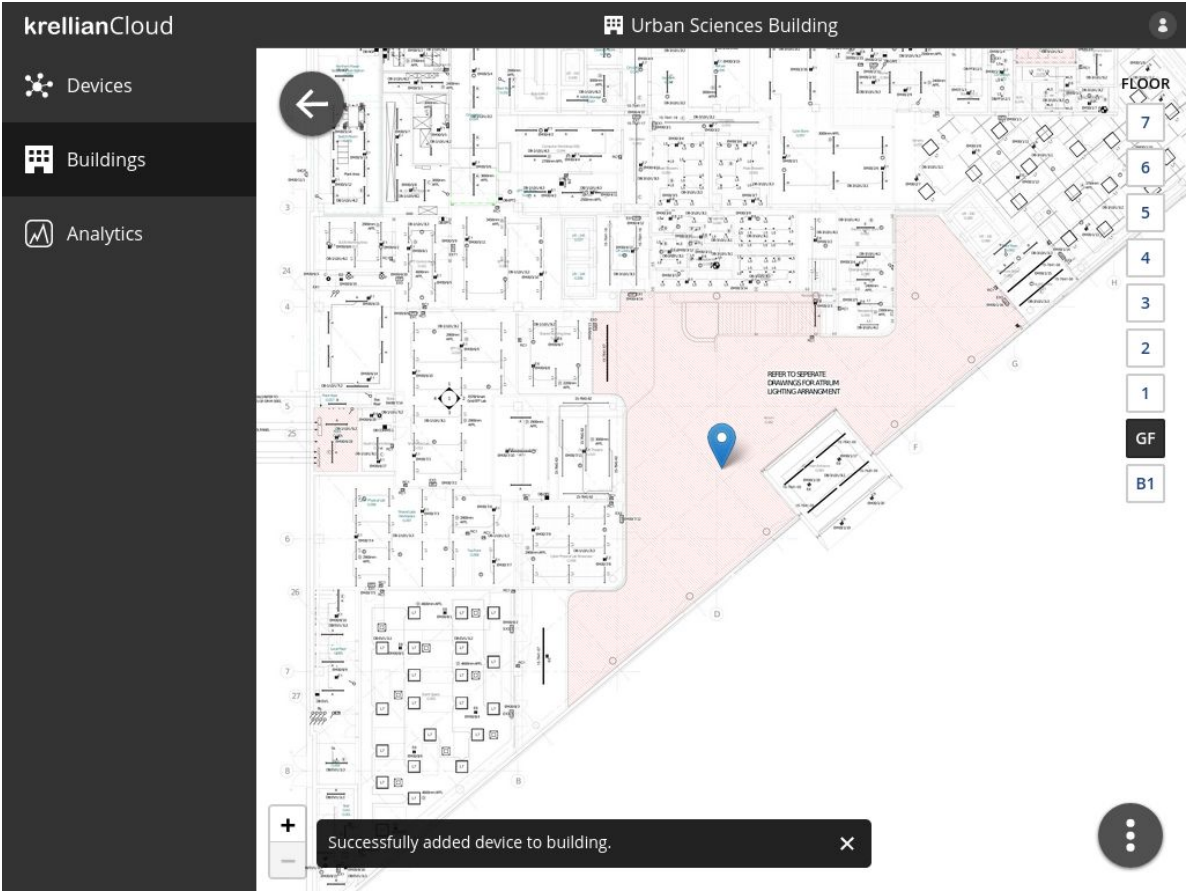
Floor Overflow Menu



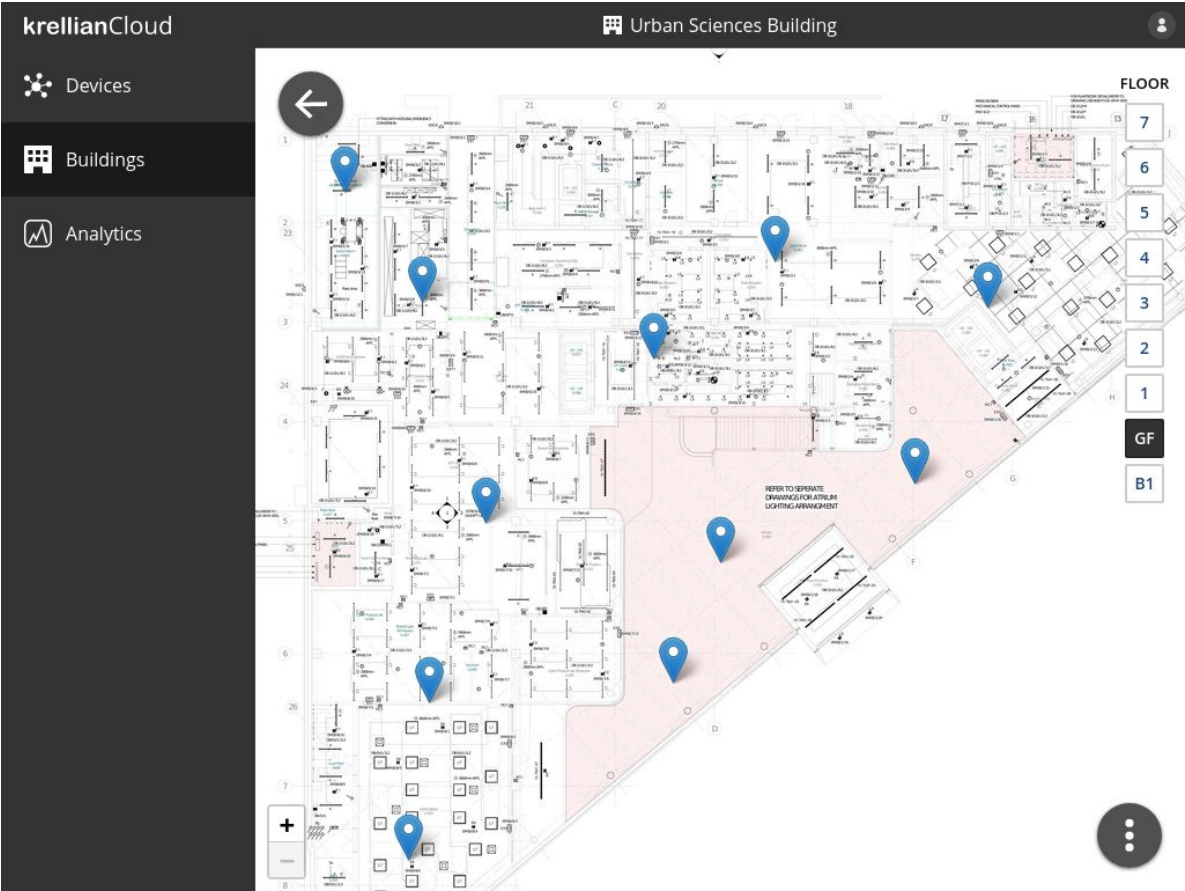
Add Device to Floor



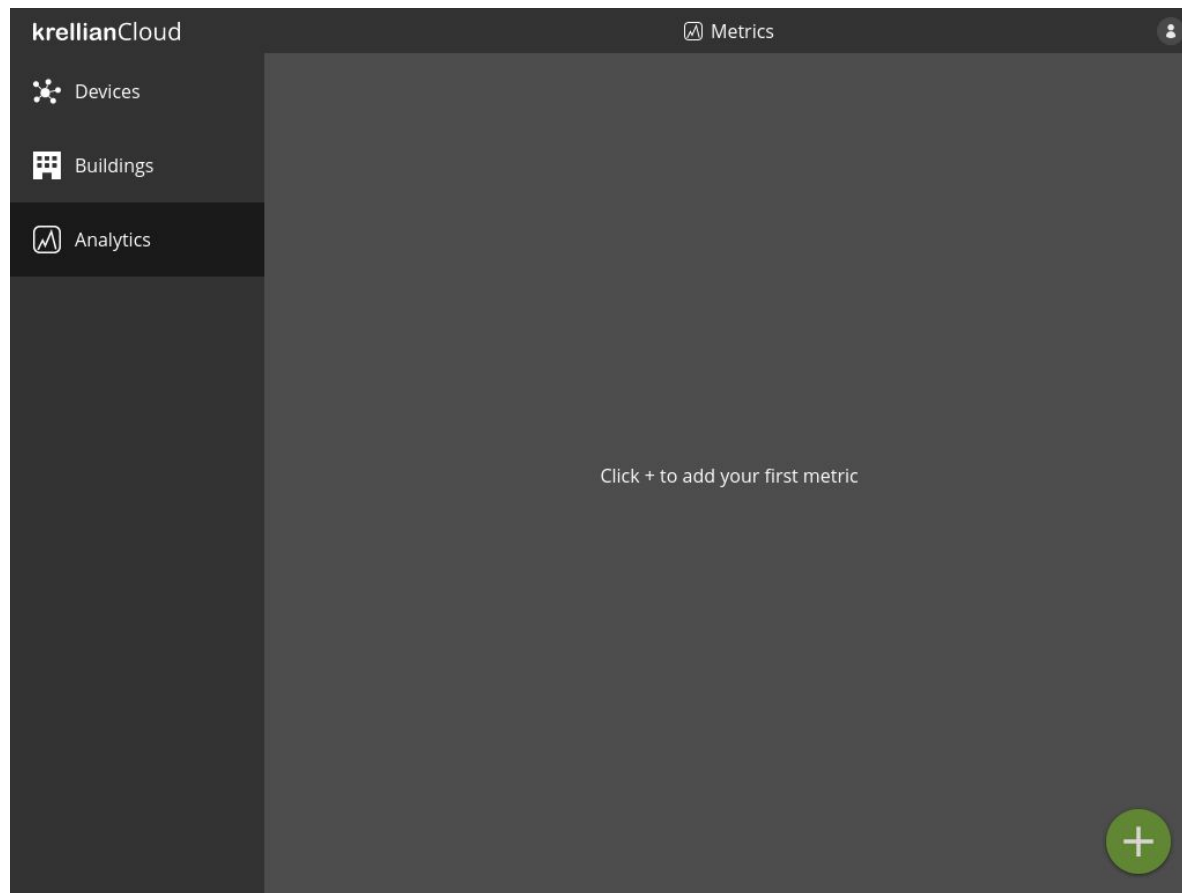
Device Added to Floor



Devices on Floorplan



Analytics



Add Metric

krellianCloud Metrics

Devices

Buildings

Analytics

×

Add a Metric

NAME

Lobby Temperature

DEVICE

Temperature Sensor ▼

PROPERTY

Temperature ▼

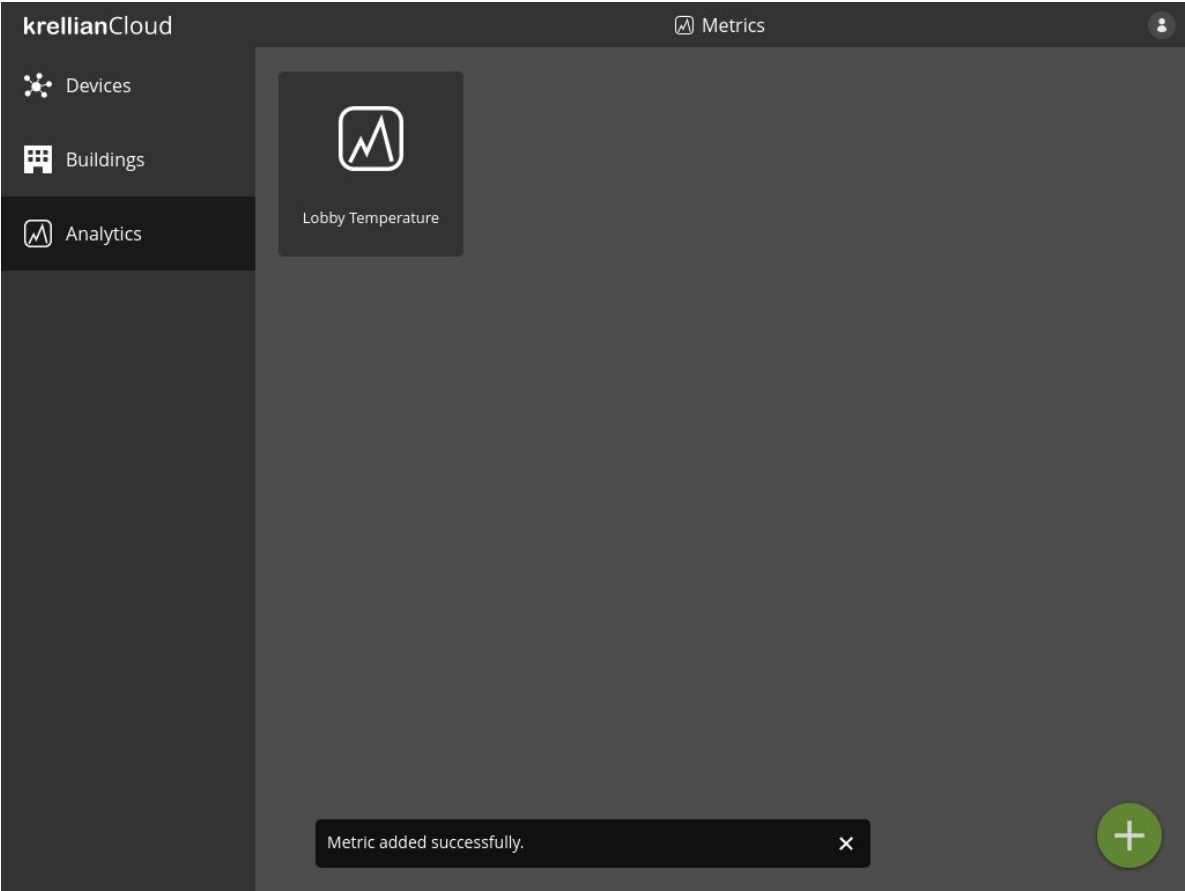
RETENTION

7 Days

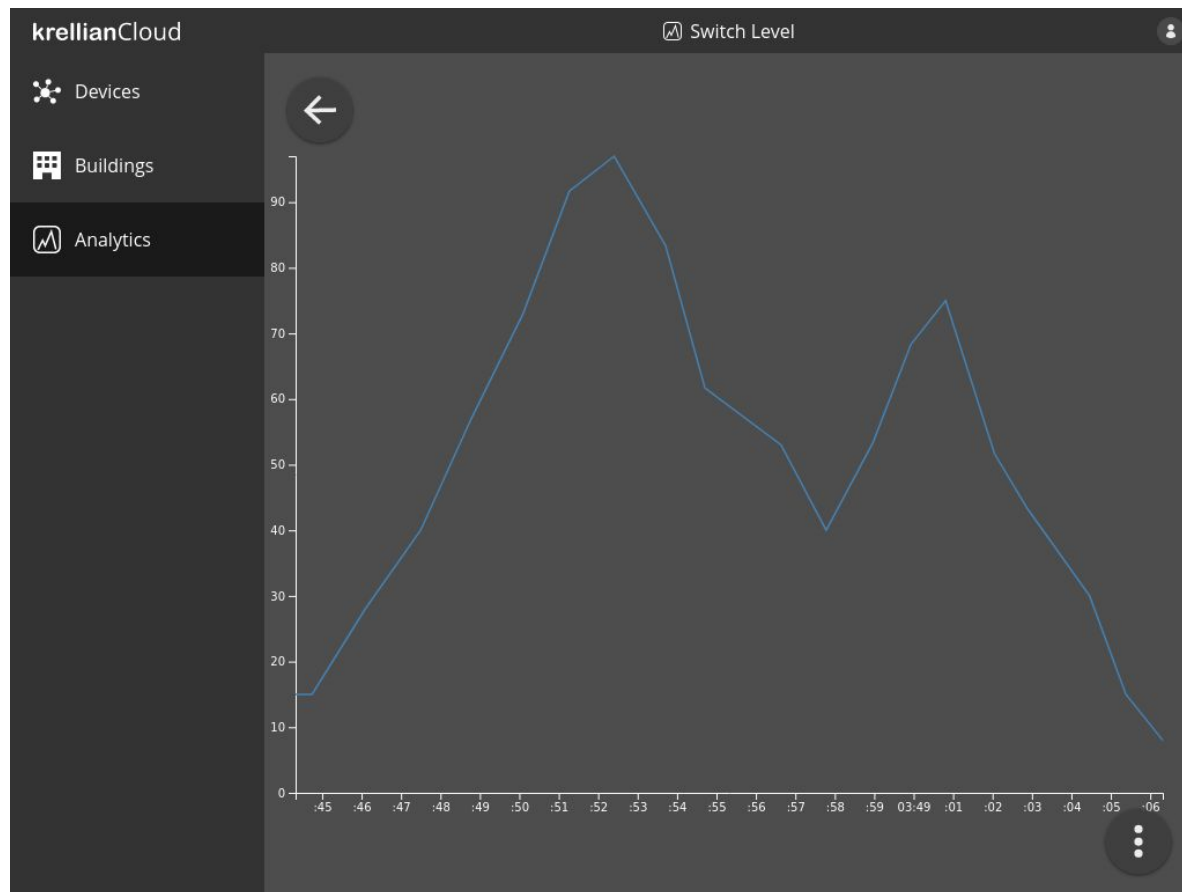
Cancel Add

+

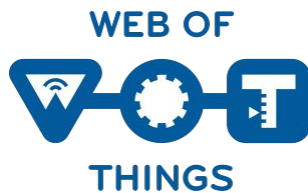
Metric Added



View Metric



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

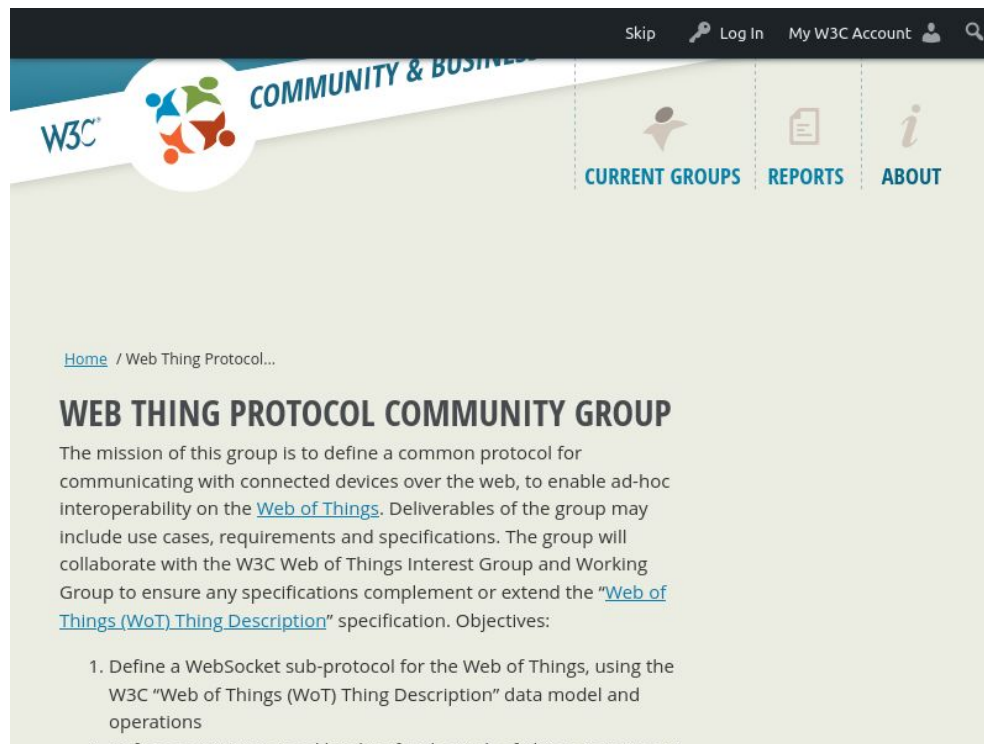
- Existing W3C/WHATWG standard
- Upgraded HTTP connection
- Uni-directional
- Requires keeping a separate TCP socket open for each affordance
- Limitations on the number of simultaneous connections that can be kept open

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



The screenshot shows the homepage of the Web Thing Protocol Community Group. At the top, there is a dark navigation bar with links for 'Skip', 'Log In', and 'My W3C Account'. Below this is a white banner with the W3C logo and the text 'COMMUNITY & BUSINESS'. To the right of the banner are three icons representing 'CURRENT GROUPS', 'REPORTS', and 'ABOUT'. The main content area has a breadcrumb trail 'Home / Web Thing Protocol...' and a heading 'WEB THING PROTOCOL COMMUNITY GROUP'. The mission statement describes the group's goal to define a common protocol for communicating with connected devices over the web, enabling interoperability on the Web of Things. It mentions collaboration with the W3C Web of Things Interest Group and Working Group to ensure specifications complement or extend the 'Web of Things (WoT) Thing Description' specification. The objectives listed are:

1. Define a WebSocket sub-protocol for the Web of Things, using the W3C "Web of Things (WoT) Thing Description" data model and operations
2. Define an HTTP sub-protocol for the Web of Things (WoT) Thing Description

<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](#))

Copyright © 2023 the Contributors to the Web Thing Protocol Specification, published by the [Web Thing Protocol Community Group](#) under the [W3C Community Final Specification Agreement \(FSA\)](#). A human-readable [summary](#) is available.

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[writeProperty](#)

[observeProperty](#)

<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 `ttdl` 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/1msgUzSmiTrqVieU2l_V2804gqvVsHrYByTy-OET1l8/edit?usp=sharing

Author:

[Ben Francis \(Krellian\)](#)

[Introduction](#)

[Vocabulary](#)

[Default Protocol Binding](#)

[Properties](#)

[readproperty](#)

[writeproperty](#)

[readallproperties](#)

[writeallproperties](#)

[readmultipleproperties](#)

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[Actions](#)

[invokeaction](#)

[ActionStatus object](#)

[Synchronous Action Response](#)

[Asynchronous Action Response](#)

[quervaction](#)

[cancelaction](#)

[quervallactions](#)

[Errors](#)

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/1LjBWigQZXi85gXP2NNckQni5os6dwxW6UDGrZDb3cns/edit?usp=sharing>

Author:

[Ben Francis \(Krellian\)](#)

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[Identifier](#)

[Protocol Bindings](#)

[Payload Bindings](#)

[Error Format](#)

[Date Format](#)

[Security Mechanisms](#)

[Discovery Mechanisms](#)

[Link Relations](#)

[Semantic Contexts](#)

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



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