

Casambi System Overview

Introduction

This document is intended to provide an overview to specifiers involved in lighting control design activities. It is not intended to replace statutory, mandatory or recommended design documents.

Wireless Mesh Solution

How does it work?

Casambi is an advanced lighting control solution based on Bluetooth Low Energy (BLE), the only low power wireless technology in all modern smartphones, tablets and even smart watches, making it the only mainstream and future proof low power radio technology in the world.

Casambi technology can be integrated into fixtures, LED-drivers, LED-modules, switches, sensors and different kinds of control modules creating an optimal solution in terms of ease of installation and functionality with minimal additional hardware and deployment costs. Casambi ready products, that are produced by Casambi partners and are 100% compatible with Casambi's native products.

Casambi technology provides a mesh network where all the intelligence of the system is replicated in every node and, in such a way, creates a system with no single points of failure.

The Casambi app works as one of the user interfaces in a Casambi lighting control solution, as the commissioning tool and as well as a remote gateway. The Casambi app works with iOS as well as Android devices. The app is free to download from Google Play and Apple App Store.

How Casambi differentiates from other wireless solutions

All wireless lighting control solutions may have different drawbacks caused by their network topology. Some solutions use routers or gateways for the basic functionality of the networks. The failure of such devices can cause a total system-wide failure or failure of the local devices connected to the specific gateway.

With standardized Bluetooth wireless mesh protocol, different manufacturers may have different implementations of the firmware and software, on which the standard Bluetooth mesh communication is run. This means that it can cause interoperability issues, as well as restrictions when it comes to adding new features, correcting bugs or enhancing performance of the system.

Interoperability in ecosystem

All ecosystem products (Casambi's native products and Casambi partners' products) have the same core which allows a seamless communication between all ecosystem products even from different manufactures.

The real interoperability is achieved through every product in the mesh network operating in the same environment using the same resources (Firmware, Microcontroller, Radio, RAM, Flash, ...).

This ecosystem architecture allows Casambi networks to be easily configured and updated in real time over-the-air. It means immediate feature and performance updates in all devices in a mesh.

Interoperability with other standards

Casambi supports key standards that have a significant market presence. Some of the standards that Casambi is compatible with today are:

- DALI
- EnOcean
- 0-10V & 1-10V
- PWM controllable LED strips
- Phase cut dimming
- Relay input & output

Hardware Overview

Casambi Products











Casambi provides two types of products:

CBM = Casambi Bluetooth Module

It is a chip for integration projects and requires additional electronics design. There are two versions: CBM-002 and CBM-003. The CBM-003 supports Bluetooth 5 and is replacing the previous version to improve performance.

CBU = Casambi Bluetooth Unit

CBUs are multipurpose devices with an embedded chip.

Product	Image	Name	Description
CBU-003		Casambi Bluetooth Module	CBM-003 contains a powerful 32-bit ARM® Cortex®-M4 CPU and a 2.4 GHz transceiver with an onboard antenna.
CBU-ASD-LR		Analogue Stand-alone/Sensor DALI - Long Range	CBU-ASD-LR is a wireless control unit for LED drivers with 0-10V, 1-10V or DALI dimming interface. It is possible to configure to support “no voltage” push button or to work with a standard PIR sensor (via smart-switching).
CBU-TED-LR		Trailing Edge Dimmer- Long Range	CBU-TED-LR is a trailing-edge dimmer for operation of incandescent lamps, dimmable LED lamps and dimmable LED control gear. It can also be configured as a sensor unit.
CBU-PWM4		Pulse Width Modulation 4-ch	CBU-PWM4 is an enabled four channel PWM dimmer for constant voltage LED loads, such as LED strips and constant voltage LED modules. It is connected between a 12-24 VDC power supply and the constant voltage LED load.
CBU-DCS		DALI Controller Slave	CBU-DCS is a Casambi enabled DALI controller. It does not have its own power supply and it is powered directly from a DALI bus. CBU-DCS can be used with a DALI sensor for presence detection or daylight harvesting. CBU-DCS can be configurable as a DALI Gateway.
CBU-ASR		Analogue Sensor Relay	CBU-ASR has two 0-10 VDC outputs. For tunable white applications, it is an ideal match for one or two-channel dim-to-off drivers that provide auxiliary power. CBU-ASR also has a sensor input which works with all standard low voltage occupancy sensors. The sensor input can also be configured to accept a signal from a light sensor.
CBU-A2D		Analogue 2-ch. / 1x DALI	CBU-A2D can control one or two 0-10V controllable LED drivers, or it can control a tunable white LED driver with two 0-10V control interfaces. The product can also be configured into a DALI mode where it can be connected to a DALI LED driver or DALI sensor for the presence and/or daylight harvesting functions. CBU-A2D has a universal 100-277 VAC input voltage range.
Xpress-LR		“X” layout switch panel- Long Range	Xpress-LR is a wireless user interface for controlling Casambi enabled luminaires. The four target buttons can control individual luminaires, groups, scenes, animations, and elements. Xpress-LR has buttons for dimming and also up/down buttons that can either control the colour temperature or direct/indirect light ratio adjustment.
CBU-TDP-LR		Trailing-edge Dimming Pack - Long Range	CBU-TDP-LR is a trailing-edge dimmer for incandescent lamps, dimmable LED lamps and dimmable LED control gear. CBU-TDP-LR can control up to 50 W at 120 VAC. It features an overcurrent and over temperature protection.
CBU-ARP-LR		Analogue Relay Powerpack - Long Range	CBU-ARP-LR is designed to control a single 0-10V LED driver. If the LED driver cannot be turned completely off from the 0-10V control interface, CBU-ARP-LR has a built-in 2.0 A relay for cutting the power from the driver. It also has a 12-24 VDC input for motion sensor.

CBU-TDP-LR and CBU-ARP-LR are available only for USA and Canada market.

Ecosystem Products

The Casambi lighting control systems offers 'Ecosystem Partners' the ability to utilize and design Casambi into their products. All devices use the same programming software to ensure compatibility. Suppliers across the globe offer solutions to enhance the Casambi portfolio for indoor, outdoor and architectural use across a wide range of applications. The portfolio is forever expanding, currently the ecosystem products cover the following areas:

- Luminaires
- Drivers
- Switches
- Sensors
- Broadcast Devices
- Relays
- Blind/Curtain/Roller Controllers
- Lamp/Pole Top IP Devices
- Air Purification
- Air Quality Monitoring
- Touch Screen Controllers
- Phase Monitoring
- AV Integration
- BMS Integration

Radio Performance

Casambi units use Bluetooth Low Energy (BLE) which is a high frequency radio signal (2,4GHz).

Two communication frequencies are automatically set when creating the network, but they can manually be changed to other frequencies if specific frequencies need to be avoided. Interference with standard Bluetooth is minimized as Casambi networks operate on different frequency channels.

Any high frequency RF signal is greatly affected by its surroundings. Real life achieved communication distance does not depend on the Casambi device but on the materials and obstructions around or close to the Casambi units which can reduce or block radio signals. For example, a luminaire with a metal enclosure will have a shorter communication distance than an identical looking luminaire made from plastic.

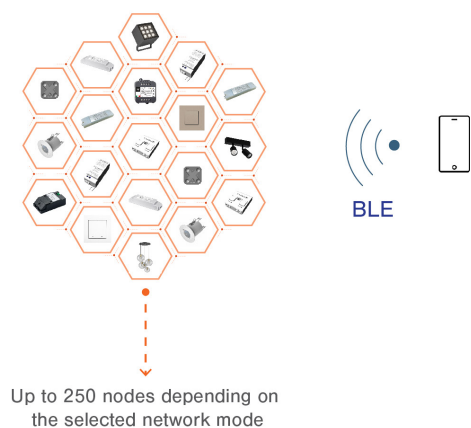
Poor placement or material selection may cause problems. This is why a careful planning and vigorous testing is required to achieve a good performance.

Here are some placement considerations:

- Placing units in direct line of sight provides the best communication possibilities.
- Small barriers may also only have a minor affect.
- The physical distance between Casambi devices is also important since the signal strength will reduce the further the devices are from each other.

Network types

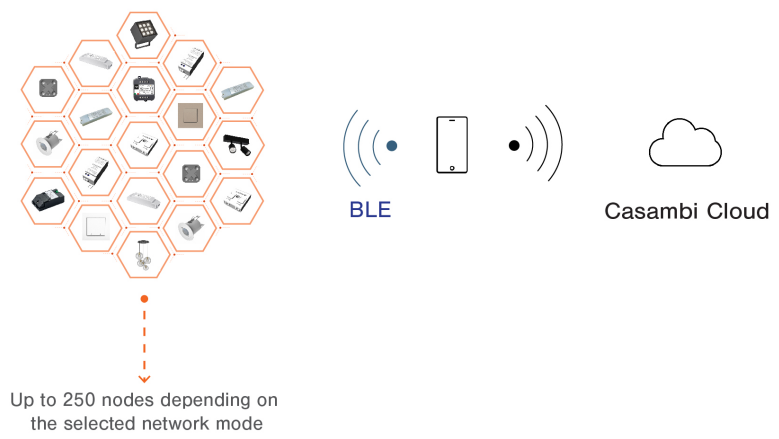
Casambi network operates without an internet connection. A Stand-alone network consists of nodes communicating through BLE and the Casambi App as a commissioning tool and end-user interface.



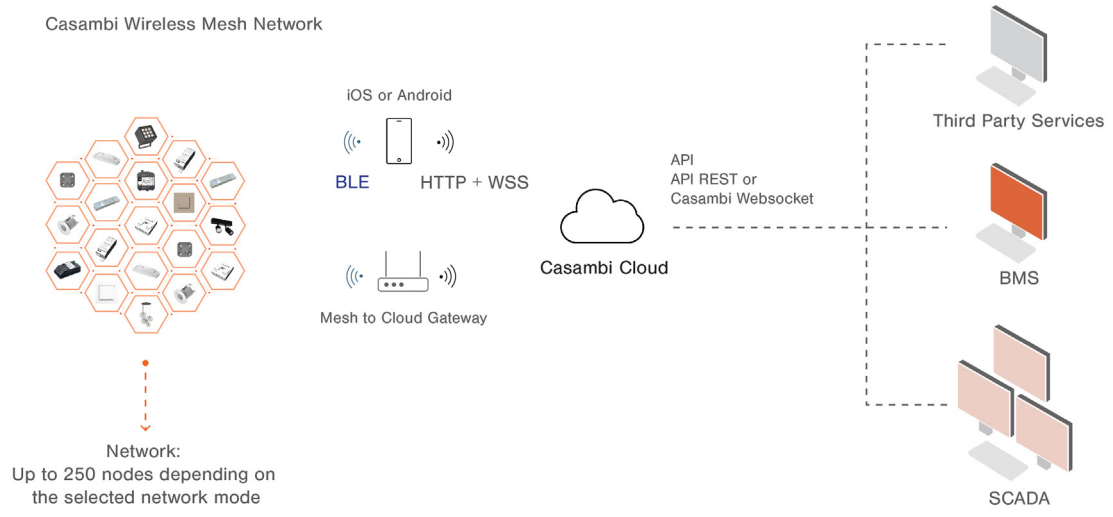
Casambi stand-alone network

An internet gateway can be used if it is required to have remote control over the network or to interface building management systems or third-party services via the Casambi Cloud API.

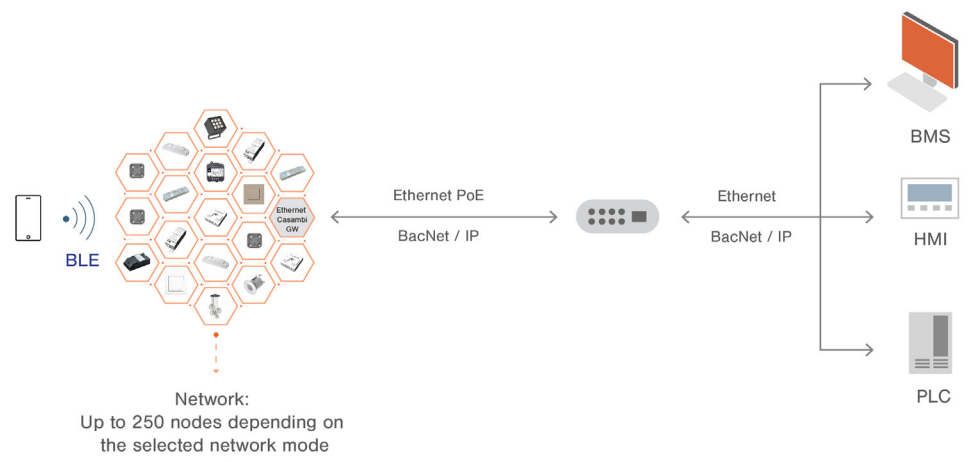
Alternatively an Ethernet Gateway can be used to interface other systems or protocols without going to the Cloud, keeping all data inside the premises.



Casambi wireless mesh to cloud network



Casambi BMS integration via cloud API



Casambi BMS integration via Ethernet Gateway

Network modes

Different network modes can be selected when creating a network. Network modes affect communication speed, range, and recommended device density in the network.

There are 3 network mode options:

Balanced: This provides the ideal balance between communication speed (1 Mbps) and range for all types and versions of Casambi devices. Recommended number of nodes: up to 125

Better performance: Has a faster communication speed (2Mbps), but at the cost of slightly reduced signal strength. Networks with a large number of devices which are also situated very close to each could use Better performance mode. This is the default Mode for a Classic or Evolution network. Recommended number of nodes: up to 250 with a moderate amount of data in the network.

Long range: It offers a superior communication range between units with sufficient data capabilities at a communication speed of 0.512Mbps. For Long Range networks Evolution is recommended. Recommended number of nodes: up to 60.

Security

Network accessibility

With Casambi, it is possible to control access rights to the network and to define who interacts with the lights. The mesh network has 4 security levels that can be chosen and modified directly from the app:

Open: free and open access for anyone without requiring a password. Modifications require an administrator password.

Not shared: network details stored only on device used to create the network. Other devices cannot access the network.

Password protected: possible to use and edit network with a visitor password, except sharing settings.

Administrator only: only administrator(s) can access with an administrator e-mail and password.

When the network is in 'Not shared' mode, there is no cloud communication. When the network is in 'Administrator only', 'Password protected' or 'Open' mode, the Casambi mobile application will send a (backup) copy of the network configuration to the Casambi cloud.

As an additional measure to manage security and the integrity of data, Casambi provides different levels of access for users:

Admin: Has full control of all network aspects.

Manager: Can configure the network (i.e., change programming), but not create new user accounts.

User: Can only use the network but cannot make any programming changes.

Up to 10 access tokens can be set for either User, Manager, or Administrator roles.

On the network level, other accessible possibilities are also provided:

- Device lock to prevent unpairing (without administrator access).
- Update of firmware can also be disabled to prevent any changes occurring at the firmware level.
- Network configuration can be backed up to the cloud via a mobile phone app.
- The devices of a network can be hidden from other users.

Communication channels and security

Each Casambi network contains 3 main communication channels:

- Communication from unit to unit in mesh network
- Communication between mobile and unit/mesh network
- Communication between gateway and cloud (only if cloud connection is required)

Since Casambi has different communication channels and offers a multitude of solutions various encryption algorithms and techniques for securing data are used:

- 128-bit AES: Symmetric encryption cipher.
- AES-CMAC: Message authentication algorithm for data integrity.
- ECDH: Elliptic curve key exchange.
- ECDSA: Elliptic curve digital signature algorithm.
- Full encryption between mobile device and units. New encryption key for each connection, derived with ECDH.
- 10 changeable passwords.

Over-the-air updates allow Casambi to push new security features and software patches out to the entire fleet of installed devices at once.

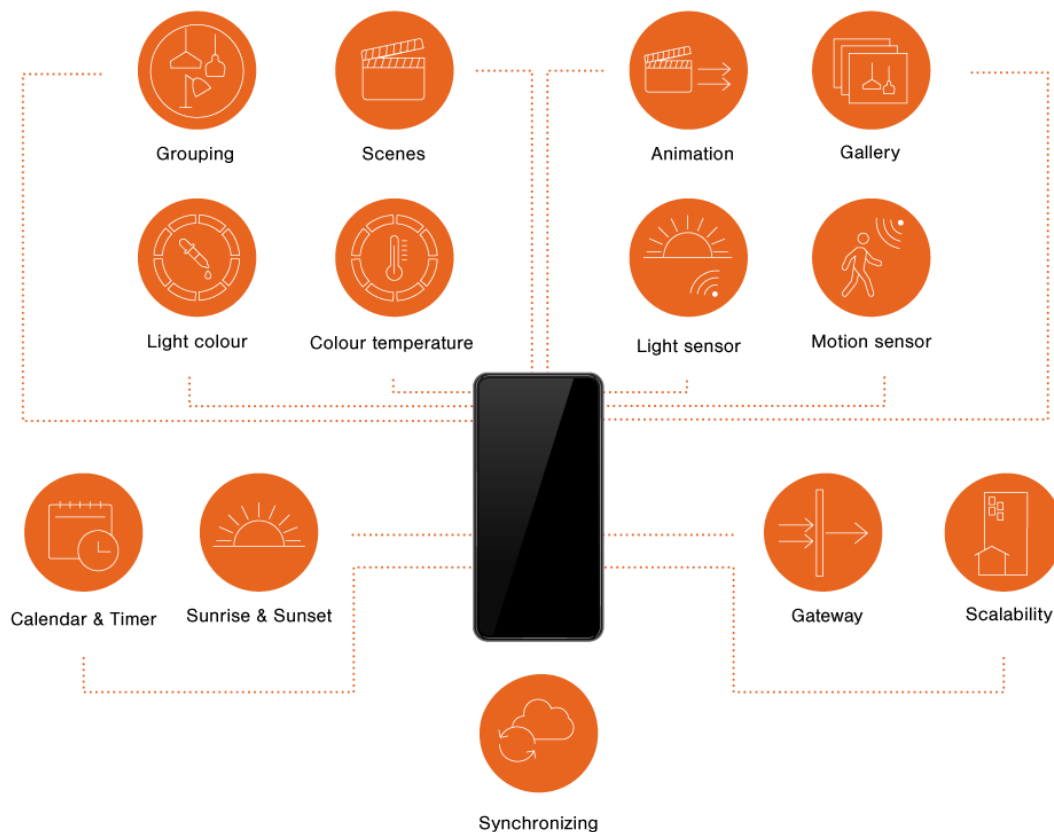
Cloud security

The Casambi servers, located in Europe, are firewalled and monitored 24/7. They are kept up to date with regular security updates, are accessed only by limited personnel and all the stored information is encrypted.

Casambi has received ioXt Alliance cybersecurity certification for its system, affirming its ongoing commitment to network security for customers and stakeholders.

Lighting controls functionality

The Casambi solution provides all the control options expected from a full-featured professional lighting control solution.



Grouping: is a method of organizing luminaires. This can make it easier to find the correct luminaires later (especially in a large network). One luminaire can only be part of one group. All grouped luminaires can be synchronously controlled and/or programmed for individual control.

Scenes: A scene can be a certain dimming level, or a combination of a dimming level and a colour, a combination of a dimming level and a colour temperature or a preset adjustment of the indirect/direct lighting ratio- depending on what kind of luminaire is being controlled. It shall be possible to create up to 255 scenes.

Animations: are dynamic scenes in which it is possible for the lighting to fade from one scene into another. Time, duration, and cycles can be set in the app.

Gallery: allows to personalize the user interface by uploading photos of a space or a floor plan and marking the positions of the luminaires within the images. This helps to visually identify the luminaires and intuitively interact with them.

Light color: It is possible to cruise the color spectrum and save favorites in a color palette.

Color temperature: the Casambi App provides a slider for end users to pinpoint a specific color temperature within the range.

Daylight sensor: measure the illuminance levels and report lux values back to the network. This way automated lighting scenes can be programmed to achieve maximum lighting quality and reduced energy consumption.

Motion sensor: by detecting movement, sensors can trigger scenes. It is possible to configure presence scene, absence scene, linger time and fade time.

Calendar & Timer: scenes and animations to be turned on and turned off based on a certain time and date. The options are to either choose a certain weekday or several weekdays or a specific date.

Sunrise & Sunset: by setting a lighting network's time zone and location in the app, Casambi units can calculate local sunrise/sunset times and adjust luminance levels or recall programmed lighting scenes accordingly.

Circadian control: colour temperature of tuneable white luminaires can be controlled based on day time by using a response graph that spans the hours of day on horizontal axis and colour temperature on vertical axis.

Control Hierarchy: co-operation with manual lighting control (app, switches and push buttons) and automated controls (presence sensors and timers) to create overrides and lighting control priorities.

Gateway: it is possible to enable the gateway functionality to give remote support access, facilitating maintenance or troubleshooting. A gateway connects to your Casambi lighting network via the internet.

Scalability: the site functionality allows to combine several networks virtually. Through the Site network it is possible to control several networks at the same time and to remotely control the Site-network using an Internet connection.

Network history: backups and snapshots store copies of the network program. Snapshots are saved automatically, whereas backups are created and stored manually.

DALI Gateway

A CBU-DCS or an equivalent device from the Casambi ecosystem can be used to act as a gateway between a wired DALI network (controlled by DALI controller hardware and software) and a wireless Casambi network. Before connecting the CBU-DCS to the same powered DALI bus as the DALI controller, the CBU-DCS DALI Gateway profile must be applied.

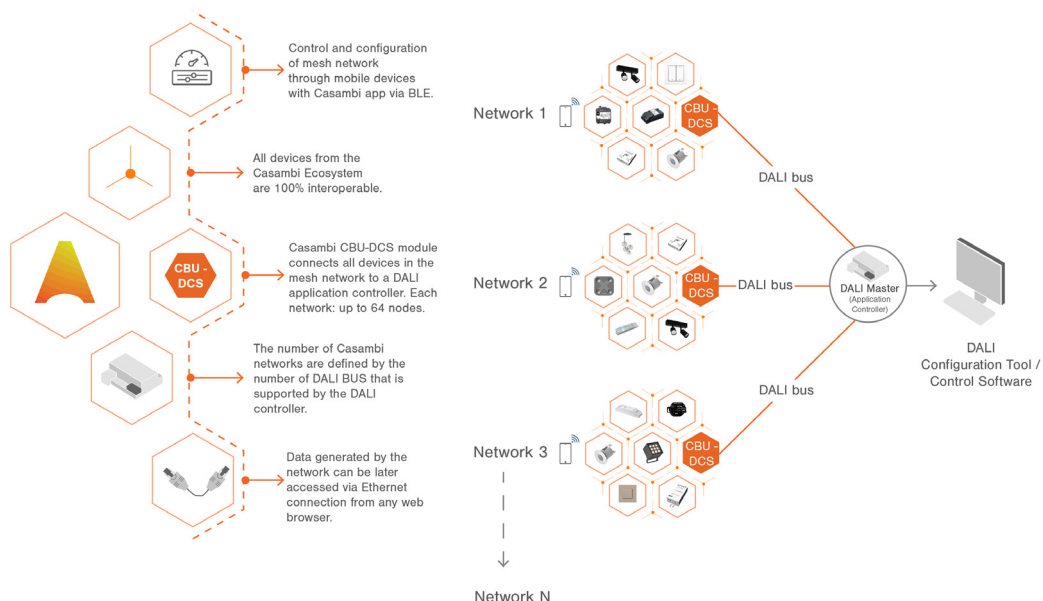
Any device which exists in the Casambi network will then appear as standard DALI gear to the wired DALI controller software. Each Casambi device uses one DALI address but the CBU-DCS DALI gateway does not; instead it appears transparent to the DALI controller software.

Casambi devices which control more than one channel appear as single-channel DALI gear to the DALI controller software, therefore the separate channels cannot be dimmed individually by the DALI controller software, only by the Casambi app.

Casambi devices which use TW, RGB or XY controls are presented to the DALI controller software as DALI or DALI DT8 (Tc/RGB/XY) devices.

All Casambi luminaires can be addressed by the DALI controller software, regardless of what type of Casambi device they are. i.e. the Casambi device does not need to be a DALI-controllable device.

A CBU-DCS DALI Gateway enables 64 input devices to be addressed according to the DALI standard, but only 80 DALI-2 “instances” can be processed by the DALI Gateway. This means that the amount of input devices possible in the Casambi network may be limited depending on the number of instances the devices use. If you wish to control more than 64 devices or 80 DALI-2 instances you should create multiple Casambi networks with a DCS DALI gateway in each.



Data with Casambi

Cloud gateway

By using a gateway it is possible to access and control Casambi networks remotely or interface Building Management Systems and other third party services. It also allows for network monitoring. There are several gateway options from Casambi and the Casambi Ecosystem:

- **Casambi Cloud Gateway:** The Casambi Cloud Gateway is a device enabling users to control and receive data from their network remotely over the internet. The device has Ethernet and Wi-Fi connections available for internet. It should be powered, and in Bluetooth range of the network it is acting as a gateway for.
- **Smartphone or tablet:** An iOS or Android device that is permanently powered can also be configured to be used as a cloud gateway from the Casambi app. It must be in Bluetooth range of the network it is acting as a gateway for and have internet connection. Casambi app must be continuously activated.

There are different gateway options also from the Casambi Ecosystem, including gateways that can be connected to local computers via an Ethernet or USB connection. Such solutions are especially suitable for occasions where the sharing of data to the Cloud is not desired. All data communication is kept locally inside the premises.

Casambi API - interfacing 3rd party systems and solutions

An API (Application Programming Interface) is a set of routines, protocols, and tools to enable custom software applications to be built. Casambi's API allows developers to connect to a Casambi system. It specifies the "building blocks" and defines what interactions are permitted. A software programmer can use the API building blocks to develop custom software applications, such as different user interfaces.

Casambi API provides 2 sets of software tools for developers:

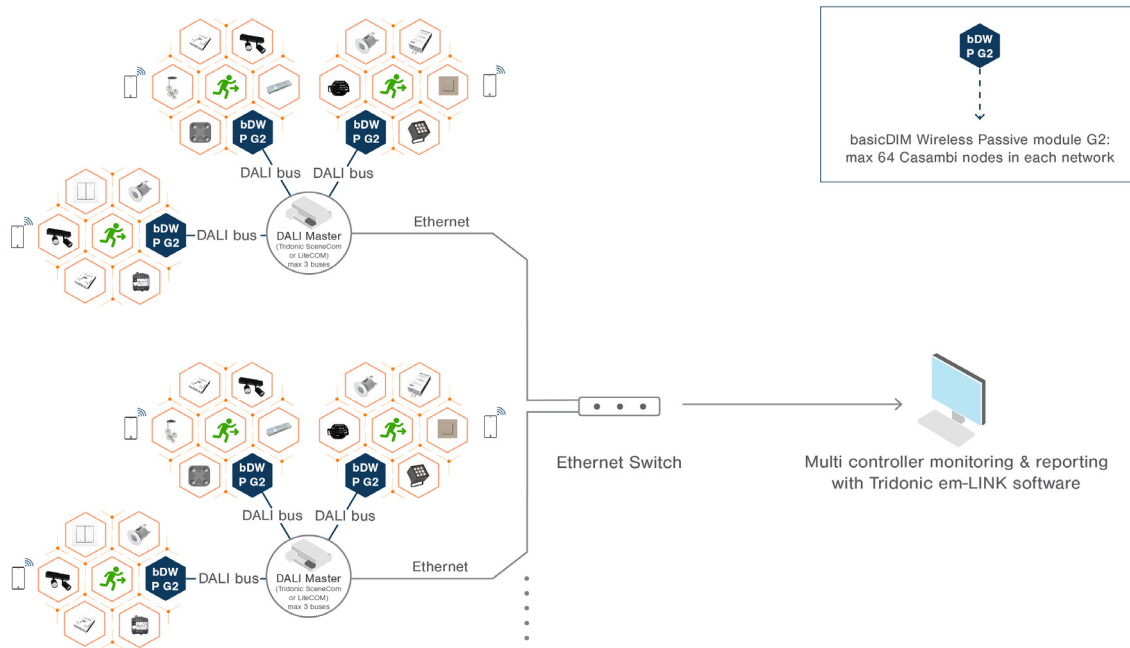
- **REST API:** for requesting "static" network information
- **WebSocket service:** for real time monitoring & control

D4i data extraction

D4i is an extension of the DALI-2 certification program. D4i LED drivers have a mandatory set of features related to power-supply requirements and smart-data capabilities. Such drivers inside the luminaire have the capability to store and report a wide range of luminaire, energy and diagnostics data in a standardized format; which can then be used for performance monitoring, asset management, predictive maintenance and many other tasks.

In a Casambi network, D4i data can be extracted and communicated for monitoring and management purposes.

Wireless Emergency



Tridonic provides wireless emergency lighting based on Casambi technology. This solution brings additional strength to the wireless mesh and overall system, as well as supporting DALI DT1 standard devices – meaning reliable interoperability with DALI local battery emergency control gear. DT1 interoperability provides advanced data extraction capabilities from devices for any other analytics that may be required.

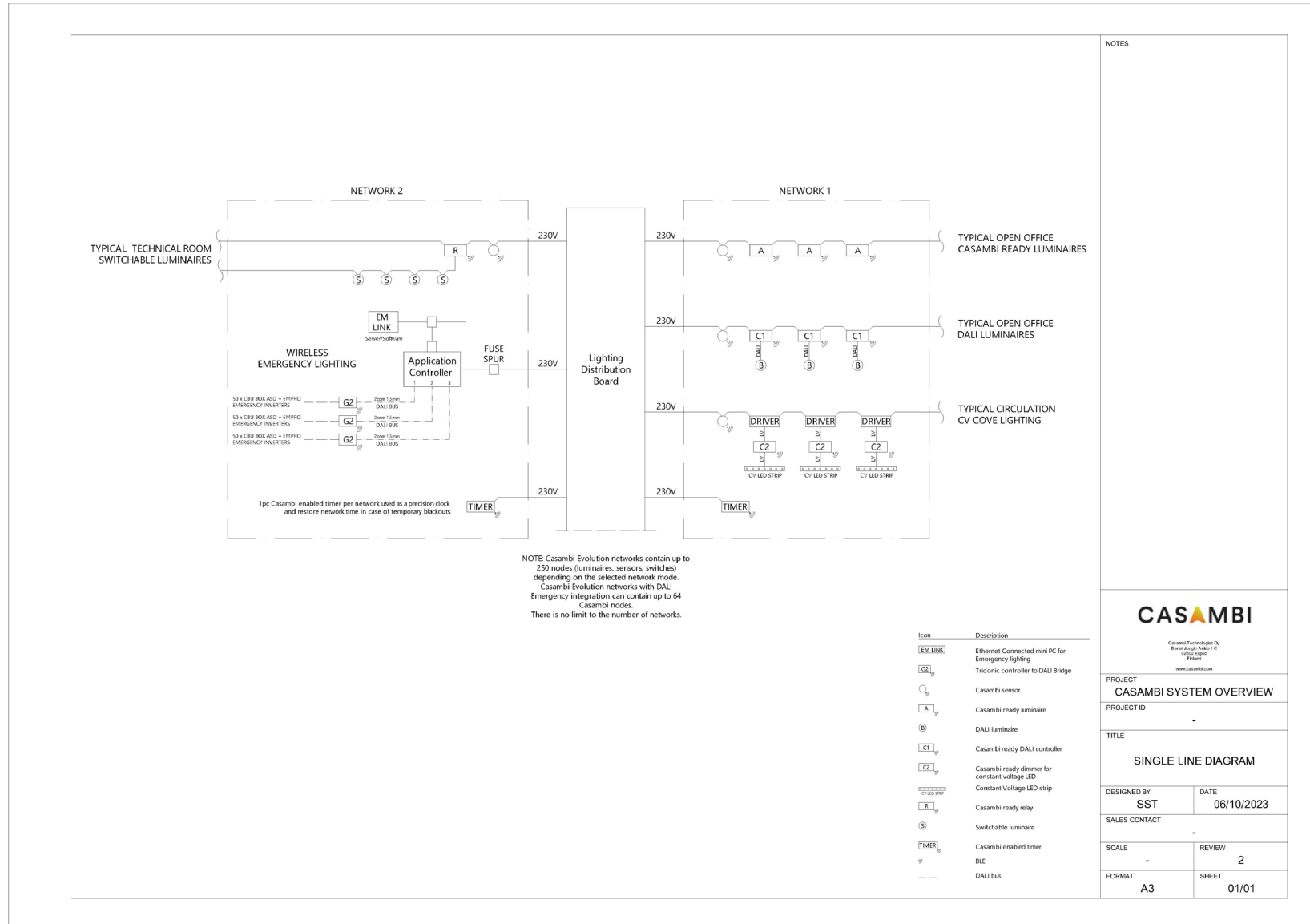
The basicDIM wireless Passive bus module G2 connects all the wireless emergency luminaires to a sceneCOM evo controller. Once commissioned, the controller acts as the “brain” and takes over command of the entire lighting solution – fully automated and exactly as the user requires. This also applies to the required central monitoring and automated testing of emergency and safety lighting systems.

This solution for emergency lighting provides:

- Central monitoring of individual luminaires. The dashboard provides information at a glance about the current state of the system and the latest test results. The status of each luminaire in the network includes the condition of the battery as well as the status of the LEDs and associated electronics.
- Automatic testing of individual luminaires. The wireless emergency solution provides, via an onboard HTML page, the ability to schedule the automated emergency tests at any time and at any frequency of test. It greatly reduces commissioning time and eliminates the need to visit the site every month to action the emergency test.
- Standard-compliant logbook with all the relevant information for downloading as a PDF or XML file.

- The possibility to be integrated into existing installations without the need for additional wiring.
- External access via a PC, notebook, tablet or other internet-enabled device. The test and system data are accessed via Ethernet from any web browser.
- On request, a software package can inform the asset manager about faults and errors via email.
- Up to 200 sceneCOM evo controllers can be connected (as many as 38,400 individual luminaires).
- Firmware updates are available wirelessly on any Android or iOS device.
- The relevant components of the wireless emergency lighting system are BSI Kitemark™ certified and comply with all standards and regulations relevant to emergency lighting.

Single line diagram for a typical office application



NOTES	
CASAMBI	
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