Casambi Whitepaper

Wireless lighting control for:
Residential

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Introduction

Home is more than a physical space to live, it's a place where people feel comfortable, at one with themselves and in harmony with their surroundings. To feel the warmth, all elements of the place count, not only considering the style and personality but also the functionality.

Lighting is not palpable like furniture. While your personal effects can be easily seen and felt, lighting design plays an inconspicuous yet important role in the home and how people feel within it.

The same room can transmit different sensations at the flick of a switch. With different layers of light (ambient lighting, accent lighting and decorative lighting fixtures), it is possible to achieve different atmospheres from dramatic to comfortable and cozy ambiances.

Decorative and technical luminaires in association with a lighting control system can be used to ensure that illuminance levels, brightness and color temperature are always adjusted to suit the current tasks, needs and mood.

Casambi's wireless lighting control technology is contributing significantly to a modern-day revolution in how people are taking advantage of lighting, not only to illuminate a space but also to enjoy different experiences, increase a home's security levels and even aid with lowering the energy bill.

Casambi's mesh technology provides lighting designers and manufacturers with the ability to wirelessly link devices together enabling the creation of customizable smart lighting networks that are configured and controlled using the Casambi App. Thanks to its simplified system architecture and user interfaces, the solution is easy and fast to specify, install, commission, and use.

The Casambi system offers extremely flexible control functionality that brings new dimensions to design and total freedom to create: from tweaking color temperature, lighting colors, dimming, human-centric lighting, blind control, to the activation of lighting in response to movement detection – to name but a few of the possibilities. By providing lighting that's fit for purpose - just the right light, in the right place, at the right time - Casambi offers a cost-effective way to reduce maintenance needs and energy consumption.

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Key drivers and trends in the residential sector

Us humans, we're always scouting easy home improvement ideas. Here are three key trends that are currentlytransforming the residential sector.

LEDs are the way to go

LED sales have increased considerably in recent years. Proven to yield energy savings of up to 70%, they're replacing fluorescent and incandescent lighting across all public, private, and commercial spaces. This movement has been galvanized by new laws banning the production and sale of new fluorescent lighting stock to phase out the use of their toxic materials, such as mercury and phosphorus.

According to the most recent results from the Residential Energy Consumption Survey (RECS), 47% of U.S. households were using LED bulbs for all or most of their indoor lighting in 2020[1]. This trend can also be perceived globally: In 2013, the LED market share was around 5% and in 2021, over 50% of the global lighting market uses LED technology according to International Energy Agency [2].

Prioritizing LED uptake and using higher-efficiency LED lighting technology are a key to achieving carbon footprint reduction and a more sustainable world. The addition of a smart lighting control system can further reduce energy use.

Well-designed and broken-plan spaces

In recent years, people have been spending more time in their homes, especially those who have hybrid, flexible or fulltime work-from-home contracts. This situation has led to a notable trend toward home designs that make better use of space. Distinct zones are created using semi-permanent partitions that can be moved around to offer more flexibility.

Open and multifunctional spaces require versatile and well-planned lighting to integrate and zone successfully. The lighting solution should offer the opportunity to easily jump between different lighting scenarios according to activity and mood – ie. From work mode to chillax time.

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[1]   U.S. Energy Information Administration. https://www.eia.gov/consumption/residential/index.php

[2]   IAE Lighting report – September 2022. https://www.iea.org/reports/lighting

Incorporating biodynamic lighting for well-being

Modern society is spending extended periods of time indoors which means we're not being exposed enough to the natural daylight that our bodies need and crave. Light deficiencies can cause health problems since it disrupts the natural circadian rhythm and affects quality of sleep.

LED lighting technology has introduced a new approach to lighting design, called biodynamic lighting or Human-Centric Lighting. Focusing on satisfying our craving for the sun's rays , tunable lights with a dynamic color spectrum allow artificial light to mimic natural light.

This Human-Centric Lighting approach is becoming more common in offices, hospitals, and schools. As the benefits thereof are felt, little by little people are incorporating it into their homes to cultivate a more positive mood, better health and well-being.

Smart Home and Interoperability

Interoperability between various systems or devices used in homes has traditionally been less than optimal. We want and need our smart security, lighting and heating systems to talk to each other. The Connectivity Standards Alliance, formed by the many big names in the field including Amazon, Apple, Comcast, and Google, has set out to develop a global connectivity standard called "Matter", that will enable IoT devices and ecosystems from participating companies to communicate with one another easily and securely, regardless of brand. As a participating member, Casambi is fully committed to supporting Matter.

Matter will provide a shared foundation on which to build an application for connecting devices and will eventually make it easier to control more devices with smart home and voice services. Currently, Casambi networks can be controlled by Amazon Alexa/Google Home systems through gateways that are offered by Casambi's ecosystem partners.

How it works

Casambi's solution forms a mesh network, which enables encrypted device-to-device wireless communication inside a lighting network. Mesh networking is essentially a low-latency, low-power mesh network protocol, which translates to a super-fast, battery-life-extending, and highly reliable connection. Bluetooth Low Energy (BLE) is used for communication between a mobile phone or the control device and the Casambi network.

Casambi's mesh topology is self-healing, which means that if a device fails, the signal flow automatically reroutes through other devices, increasing reliability through multiple nodes and redundancy of nodes. Therefore, there is no single point of failure because no single critical element that stores the information is needed for the proper functioning of the network or part of it.

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No special wiring for lighting controls is needed and all hardware complexity is reduced to a minimum. This is because no central units such as routers, controllers, or gateways are needed for the operation of a Casambi network. A Casambi network can contain up to 250 devices and each one is independent and has a backup of the entire network, i.e., all nodes of the mesh network carry the complete system intelligence.

Essentially luminaires, switches and sensors gain Casambi connectivity by either incorporating Casambi chips or by using Casambi's external Bluetooth modules. Minimal hardware is required. No cables, no internet, no routers are needed to run a network.

Up to 250 nodes depending on the selected network mode
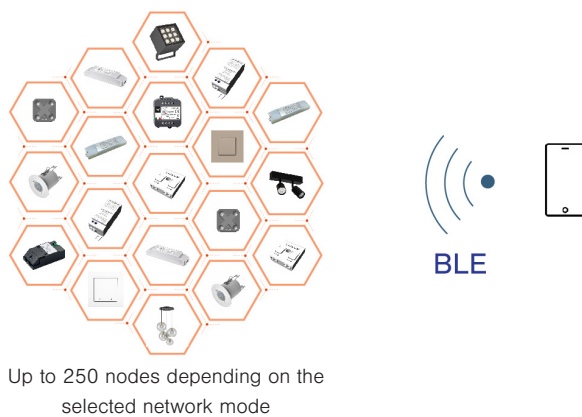
BLE

Figure 1 - Casambi Stand-alone mesh network

All system configurations and end-user controls are managed via the Casambi App on mobile devices, available for free on iOS and Android.

A Casambi network ordinarily operates without an internet connection. An internet gateway can be used if it is required to have remote control beyond the personal area network or to interface with building management systems via a cloud connection.
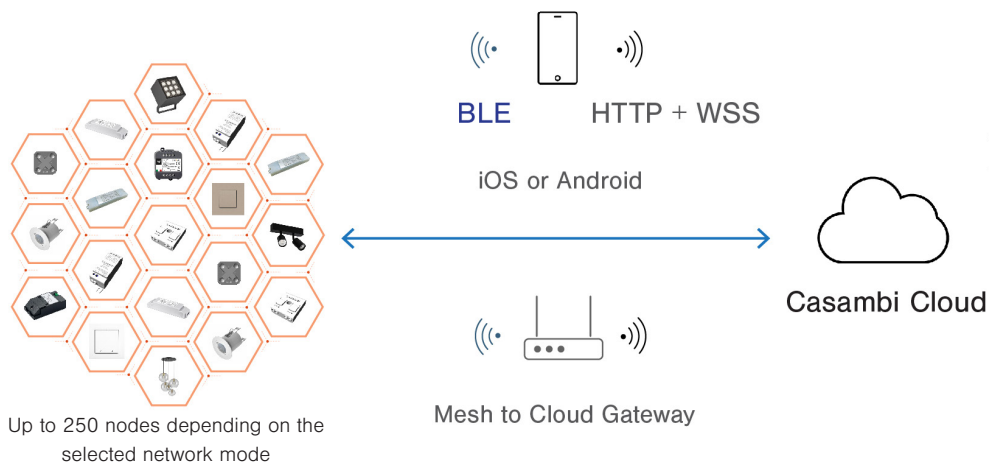

BLE   HTTP + WSS

iOS or Android

Casambi Cloud

Mesh to Cloud Gateway

Up to 250 nodes depending on the selected network mode

Figure 2 - Casambi wireless mesh network with internet gateway

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Casambi benefits for residential spaces

The Casambi solution caters well to today's residential installations by directly answering the need for powerful, highly customizable lighting control. Such benefits are:

Enhanced lighting design

- **A unique atmosphere** can be created through the lighting control system, which allows personalized daylight controls to balance artificial light with daylight or to generate smooth transitions between interior and exterior spaces. Circadian scenes, RGBW/TW controls, and subtle transitions between multiple time-based light scenes that run and fade through the day are other functionalities available in the Casambi solution.

- **Flexibility to support design changes without hassle**: With Casambi's wireless lighting control solution, everything can be rewired in the software. Control groups, light scenes, and automation programs can be created and changed time and again without having to consider any physical communication cables, as per a traditional wired system. For example, a new tenant can change lighting just by reprogramming it in the Casambi App according to their new needs and preferences.

- **Discrete and easy installation**: Casambi technology is fast and easy to integrate into luminaires that are not already endowed with wireless controls. The conversion to wireless connectivity is achieved simply by using a matchbox-sized external Casambi module, without the need for surface reconstruction or the pulling of wires.

Full functionality for lighting personalization

- **Static and dynamic scenes:** Preferred scenes can be created to tailor the right moods for different occasions: a romantic dinner for two, celebrating with a special party, an energizing morning shower or a relaxing evening bath after a long and busy day.

- **Time-based scenes:** It is possible to create time-based scenes that turn on, off, or dim selected luminaires to preset levels according to bespoke needs. Configuration can be from days of the week, time or based on sunrise or sunset. This is very much applicable to outdoor lights too.

- **Sunrise/sunset:** By enabling localization in the app, timers and time-based scenes can be set using local sunrise and sunset times. It is adjusted automatically based on an astronomical time clock.

- **Daylight harvesting:** Adjustable lighting strategies can be programmed and implemented – such as daylighting, whereby automated controls can adjust the lighting to maintain a target level, reducing energy costs.

- **Daylight responsive blind controls:** Casambi can control blinds to direct, balance and lock out daylight when needed preventing any disturbance from excessive glare caused by daylight.

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- **Task tuning:** Lighting can be adjusted to the optimal level for individual tasks. For example, the lighting level required for kitchen tasks may be different from that required for a home office.

Easy management

- **Intuitive interface on mobile devices:** The Casambi App has been designed by UX experts with one core principle; regardless of technical proficiency, anyone can use it. Luminaires can be intuitively controlled remotely, and easily reconfigured and recommissioned from a smart device.

- **Gallery:** The Casambi App's Gallery feature allows the user to take or upload photos of a space, or a floor plan, and mark the positions of the luminaires within the images. This helps to visually identify and interact with them. Light settings can be changed simply by tapping on the luminaires within the photo inside the app.
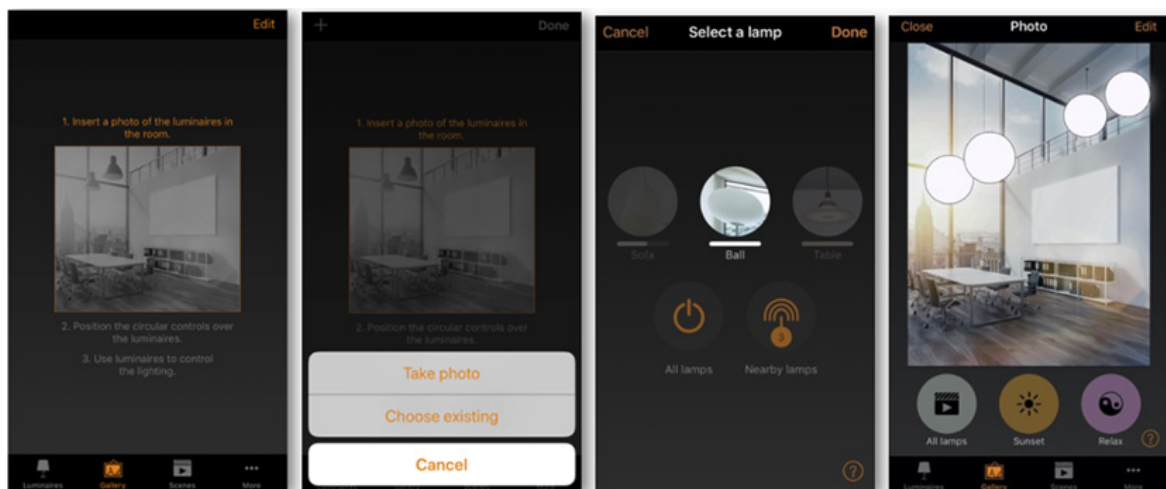

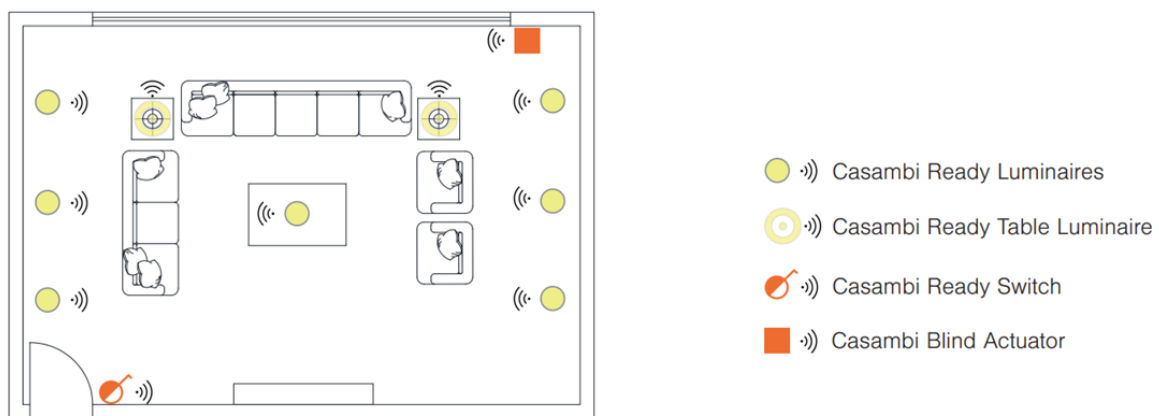*Figure 3: Gallery feature in Casambi app*

- **Reduced operation and maintenance costs:** No controllers nor any special software licenses are required to use Casambi control. The active control of lighting levels helps to extend the luminaires' lifespan, which translates to fewer lamp replacements and additional labor maintenance savings.

- **Saving energy:** By providing just the right amount of light when and where it is needed, it becomes possible to reduce energy consumption and consequently the electricity bill. Energy savings can be achieved using a multiple control strategy combining occupancy detection and daylight-responsive controls.

- **Smart home:** Casambi is fully committed to supporting the new Matter standard, a global open-source connectivity standard in development that will enable IoT devices and ecosystems from participating companies to communicate with one another easily and securely, regardless of brand.

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Application for residential

Casambi's technology is integrated into fixtures, drivers, switches, sensors, and a diverse collection of modules, that together meet all lighting control demands of the modern home. Each home is a unique world and thus demands bespoke lighting control strategies. Casambi offers different control types, functionalities, and the ability to create up to 255 different scenes.

Here is an example of how Casambi can be considered;

For a living room:

⬤ ⋑) Casambi Ready Luminaires
◎ ⋑) Casambi Ready Table Luminaire
✎ ⋑) Casambi Ready Switch
■ ⋑) Casambi Blind Actuator

Control Type	Functionality
Manual Control	With wireless smart switches, the user can switch between preset lighting scenes, dim lights down/up or adjust color temperature. All Casambi devices can also be easily controlled from the Casambi App. For example, scenes can be: Relax (warm temperature), Night (all off except one wayfinding light), Party (RGBW, animation).
Circadian scene	The color temperature (K) of ambient lighting follows a customized profile that runs automatically based on the time of day (i.e. Running smoothly from 4000K to 6500K from sunrise till noon, 6500K to 2400K from noon till end of day).
Daylight harvesting	Light outputs of luminaires that are close to the windows are adjusted based on the amount of available daylight measured by a daylight sensor. A blind actuator can also be incorporated into the Casambi system to control daylight.

For outdoor and garden:
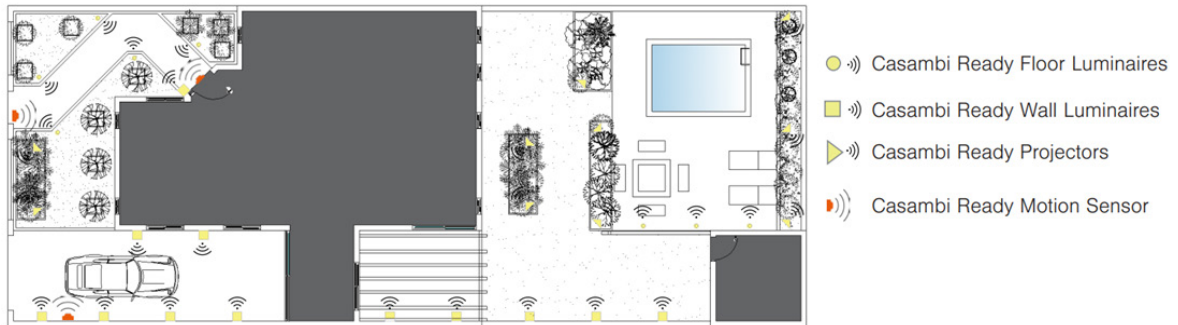
Control Type	Functionality
Sunset-sunrise scene	Luminaires switch on/off based on the astronomical clock.
Schedule	The timer function is used to turn scenes on and off based on the time or date. For example, the backyard luminaires can be turned on at 6pm and off at 11pm every day.
Movement detection (Presence)	A motion sensor can activate a scene in the garage or at the front door when it detects any movement. Occupied: Run scene Unoccupied for 5 minutes: Turn off lights

Specifying with Casambi – How to get started

Specify a project with Casambi in **five simple steps**:

1. **Every project starts with luminaire selection**. Any luminaire can be chosen, regardless of whether it is an off-the-shelf Casambi Ready luminaire or a pre-existing luminaire without Casambi connectivity. Casambi's CBU modules or equivalent ecosystem devices can convert a multitude of non-wireless devices to Casambi.

2. **When selecting sensors and switches**, for manual control, it is possible to take a switch from the Casambi Ecosystem or simply use the Casambi App as the end-user control. If a specifier wants a specific switch because of the form factor and material finish, or is working on a refurbishment and wants to keep the original wired switches, it is easy to give them wireless connectivity by deploying a Casambi unit.

3. If non-Casambi Ready devices were chosen, it's necessary to **identify the control type and select controllers** to make them Casambi enabled. Both Casambi and its ecosystem partners offer several devices that can be used to convert almost any other control method to Casambi, such as DALI, 0-10V, 1-10V, PWM or phase cut dimming.

4. **When defining the functionality and the connectivity** of the project, a specifier may find they need to link multiple networks in the same site together or to interface the lighting network with other systems. For example, it might be necessary to interface with a pre-existing DALI installation already in use on a site. In the case of interfacing BMS or other third-party systems and software, an internet gateway will be necessary to connect the Casambi network to the Casambi cloud from where data can be transferred to other systems and interfaces through the Casambi API. Alternatively, an ethernet based gateway from the Casambi Ecosystem can be used to interface other systems while always keeping the network data inside premises.

5. **When specifying the solution**, all information need to be consolidated. Full lighting control system tender texts complete with system requirements, control functionality, device specifications with datasheets, and app notes are available to download from Casambi's website.

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Case Studies

Each home is unique and has different needs. Casambi can cater to flexible lighting strategies with ease and that is why it is the perfect lighting control solution for residential projects. Our technology is tried and tested, and fast becoming the de facto standard in Europe.

To date, over 4 million Casambi Ready devices have been sold worldwide. Casambi has been specified in over 150,000 projects, spanning every application from small high-end residential to 10,000+ node industrial spaces. In addition to our Finland HQ, we have established regional headquarters in North America and APAC regions to serve our global networks. Casambi is deployed in highly sensitive environments, such as in hospitals and airports. Our system is robust in design and has been certified as cyber-secure in accordance with global standards.

You can explore some of our projects here: *https://casambi.com/projects/*

Residential Home in County Clare

The owners of this holiday home in County Clare, Ireland, sought a lighting design that would complement the surrounding landscape and provide smart, intuitive control throughout the house. For the main living space, the clients desired custom-programmed lighting scenes befitting different activities and occasions from food preparation, and entertaining mode to relaxation lighting. Scenes were created for the required scenarios and stored in the cloud for remote use.

Smart switches provide the option to control the home's lighting both manually as well as through the Casambi App on a smart device. The installed kinetic switches match the socket face finish, in keeping with the clean design concept.

Location: County Clare, Ireland

Hamburg private residence

The owner's requirements were to preserve the original structure of the building during the modernization of the house and to install music and light systems in all rooms, as well as outside, without the need to install new cables or complicated lighting control equipment.

The ground floor was completely automated and adapted to the daily rhythm of the customer. Manual control took place via iPads installed on the wall. Presence sensors were installed in rooms with little traffic like corridors. The motion detectors switch the light on, which is dimmed at night. Mirrors with sensors were installed in all bathrooms, which automatically switch on light and music when motion is detected - again the light is dimmed during the night. In the working area, the amount of blue light is automatically reduced in the evening and at night so as not to disturb the circadian rhythm.

The outdoor area is controlled by sunrise and sunset timers. With just one push of a button, the automation is started network-wide in the entire house and garden area - the button is located at every exit of the house.

Location: Hamburg, Germany

The Gallery House

Part of the design was to integrate the lighting into the structure of the house as much as possible so as to seem like no lights are visible when they are not switched on. To this end, a lot of linear lighting was integrated into the ceiling as well as coves to light up walls, stairwells and the kitchen creating a bright, airy and modern look and feel.

Casambi was chosen as the lighting control system of choice for its simplicity of installation and operation. A number of scenes were set for different activities that are conducive to the activities of the users of this space including dinner, entertainment and cleaning. The use of a Casambi Xpress switch made this lighting control system even more delightful to use for the client.

Location: Sydney, Australia

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