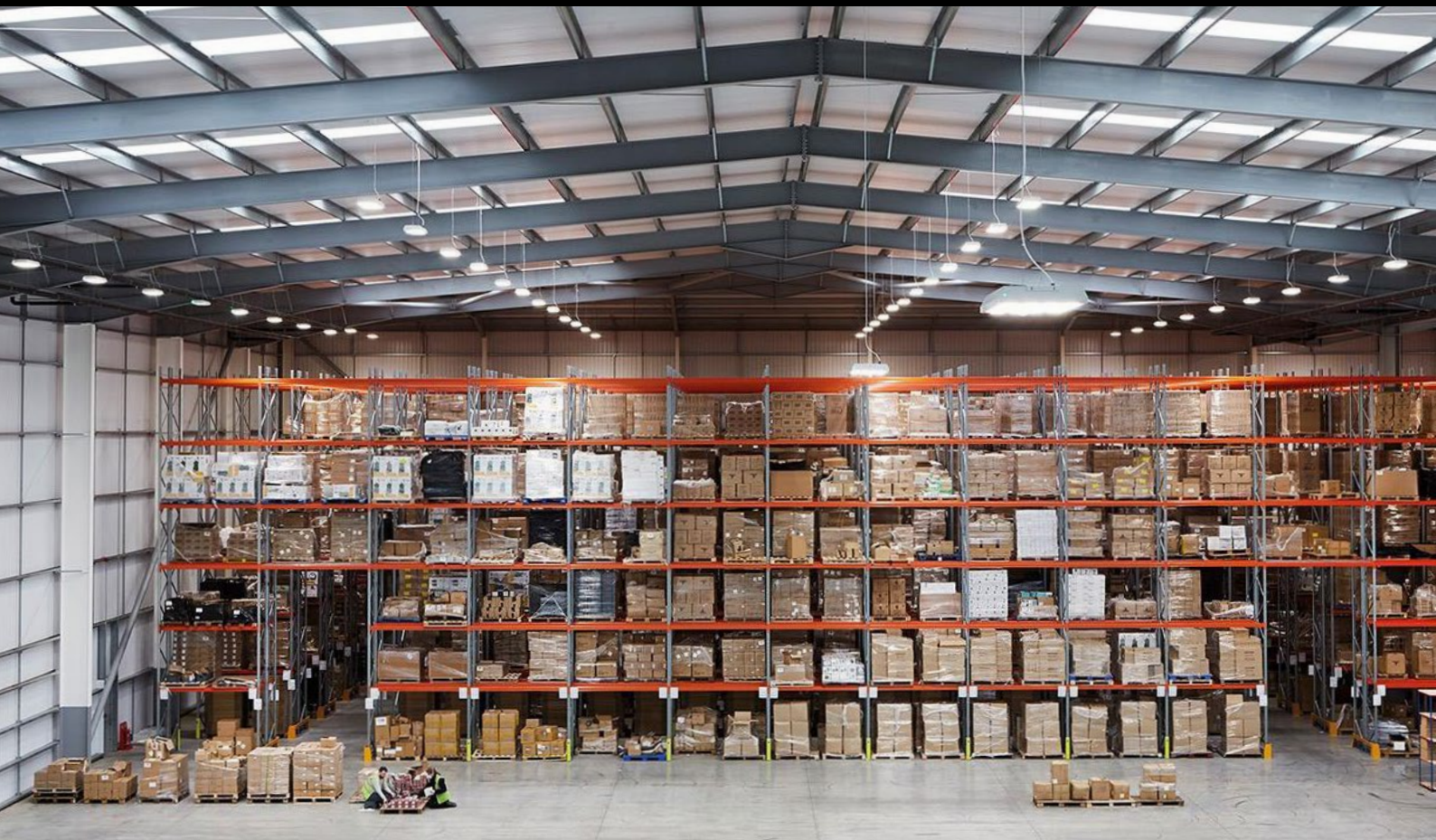


# Casambi Whitepaper

## Wireless lighting control for: Industry



Updated: January 2025

**CASAMBI**

# Preface

Wireless technologies have evolved over the last couple of decades to enable nearly anything to become connected. It is estimated that by 2030, we will be living in a wireless world in which trillions of connected endpoints will unify our experiences across the physical, digital, and human plains.

Nestled somewhere between the autonomous vehicle movement, the smart robot insurrection, and the Promised Land of the metaverse resides the wireless smart lighting control revolution. This is a market that is projected to reach USD 39.0 billion by 2024. Enabling everything from a single room set up to large-scale, multi-site lighting networks, wireless lighting control systems open the doors to a brighter future.

Casambi is a leader in modern wireless lighting control solutions based on Bluetooth Low Energy. The company was founded in 2011 with the belief that smartphones and wireless technologies will fundamentally change the way we interface with everyday objects around us. Key aspects of the Casambi solution are great user experience, high performance, and scalability from basic individual fixture controls to industrial-scale solutions with cloud-based remote control, monitoring, and data logging.

Industrial spaces are one of the more complex building types to illuminate. Wireless lighting control projects are gaining popularity in this sector owing to their proven track record of reducing energy consumption, lowering operating costs, improving safety, and providing a transparent network infrastructure that can easily scale up with minimal disruption and installation costs.

This guide outlines the transformative power of Casambi's wireless lighting control solution when applied within industrial spaces. It has been written with a view to demonstrating just how easy and joyful it can be to specify lighting solutions for industrial environments.

# Key drivers, trends, and industry dynamics

## **Going greener**

Proven to yield energy savings of up to 70%, many governments are enacting measures to ensure LEDs are taken into use in residential, public, and industrial spaces. The European Commission predicts that such efficient lighting products will also allow Europe to save up to 34 TWh of electricity per year by 2030 and will prevent around 7 million tonnes of CO<sub>2</sub> from being emitted into the atmosphere annually. Most recently, the EU has implemented new lighting regulations to further improve energy efficiency across the lighting market. As of 1st September 2021, the EU SLR (Single Lighting Regulation) has laid down new eco-design requirements for light sources and separate control gear. These span more stringent minimum efficacy thresholds on light sources and separate control gear to encourage the lighting industry to raise the bar and further improve energy efficiency beyond today's solutions. The augmentation of energy services through IoT applications such as LED light controls and sensors is also further supporting this drive to reduce consumption and achieve sustainability goals.

## **Efficiency gains**

McKinsey reports that at the outset of 2020 major factors were increasing economic pressure on industrial spaces; Trade disputes, the aftermath of BREXIT, slowing demand in China, challenges in the automotive industry, COVID-19, and other ingredients impacting global supply chains. Against this backdrop of uncertainty and change, manufacturing executives are seeking ways to deploy solutions to increase the productivity, resiliency, and efficiency of their operations – to improve operation management, inventory optimization, and human productivity.

## **Achieving uninterrupted facility operation**

Industrial sites are places where efficiency and durability are of the highest priority. According to Deloitte, unplanned downtime costs industrial manufacturers an estimated USD 50 billion per year. Over the last decade, many industrial facilities have followed the LED transition trend and invested in high-efficiency luminaires with long lifetimes. Because LED lamps typically last up to 20 years, once installed they are less likely to cause maintenance shutdowns within mission-critical environments. This long lifetime aspect is especially important as most luminaires taken into use in warehouses, workshops, or manufacturing areas are installed in locations that are either hard to reach or where maintenance interruptions will have severe negative effects on business.

Among all building types, industrial facilities (particularly industrial warehouses and storage areas) reportedly have the second-highest lighting energy consumption (46kWh/sqm per year) after retail spaces. Therefore, reducing operational and maintenance costs while increasing energy savings is very important. Workshops or production halls are areas that, in many cases, may operate 24/7, so energy-efficient luminaires and more efficient use of daylight are beneficial not only for energy savings, but also for improved visual conditions, and the general wellbeing of employees.

## **Improving worker welfare**

The latest version of the European standard BS EN 12464-1:2021 has put more emphasis on personalized lighting requirements for employees in the workplace. Across the pond, in the United States, the Occupational Safety & Health Administration (OSHA) of the US Department of Labor requires companies to follow specific lighting regulations in the workplace. These include recommended lighting levels across common commercial installations such as offices, factories, workshops, and warehouses. When it comes to industrial lighting standards, common application errors which lead to OSHA-induced penalties include the discovery of uncovered wiring and failing inspection due to improperly illuminated workstations. Catering to highly localized lighting needs across a large site – where one size does not fit all – is paramount to workforce health and safety. Wireless smart lighting control addresses these requirements head-on.

Tunable white light can help with the attention and focus of employees who work night shifts. Additionally, task tuning, where the local lighting level is adjusted according to the specific requirements at each task area, also helps improve comfort and safety conditions for employees, while at the same time, saving energy by 18%.

Utility companies are increasingly offering incentives and attractive time-of-use tariffs to companies that can lower their energy demand at certain peak periods. Having the flexibility to benefit from such incentives will also help reduce soaring energy bills.

# How wireless smart lighting control can help solve today's challenges

Application highlights:

## **Non-disruptive installation and rapid commissioning**

Wireless lighting can be installed without the need for surface reconstruction or the pulling of wires, and can be commissioned remotely from an app.

## **Intuitive interface on mobile devices**

Luminaires can be turned on and off remotely, and easily reconfigured and recommissioned from a smart device.

## **Occupancy detection**

Sensors can detect motion to indicate the presence of a person and automatically turn on lights only when they are needed.

## **Scheduling and timers**

It is possible to create time-based scenes that turn on, off, or dim selected luminaires to preset levels according to bespoke needs.

## **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.

## **Task tuning**

Lighting can be adjusted to the optimal level for individual areas improving safety and saving energy across a site.

## **Human-centric lighting**

As light can affect human circadian physiology, smart lighting can be programmed to follow sleep cycles to positively affect health, alertness, and productivity.

## **Wireless emergency lighting**

If emergency services are called for, lights can be swiftly and remotely controlled to shine at maximum brightness for increased visibility.

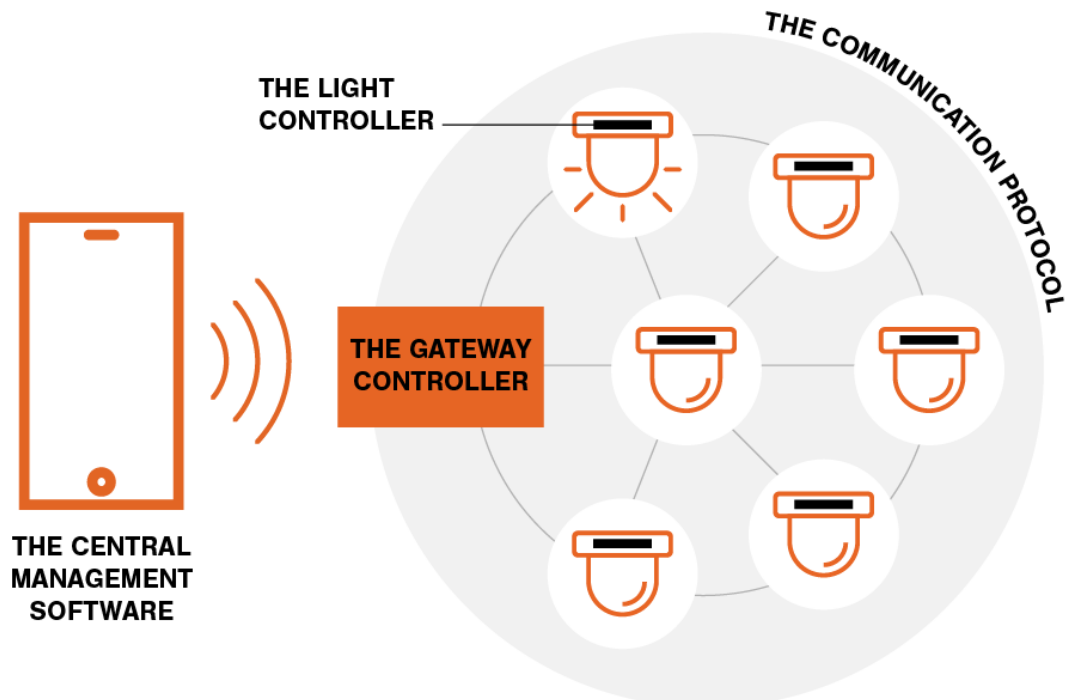
## **Environmental monitoring**

Connected lighting can be used as an onramp for other applications such as remote air quality control, dangerous gas leak detection, or noise pollution monitoring.

# The building blocks of smart lighting control

Wireless smart lighting systems principally comprise four elements:

- **The light controller** This is the communication transceiver that controls the driver or the light-sensitive module within a luminaire itself.
- **The central management software** This gathers data and controls all the luminaires in the lighting network. Isolated lights can be remotely controlled or can be grouped together and controlled synchronously.
- **The communication protocol** This is the system of rules that allows lights within a network to exchange messages without the need for wired communications.
- **The gateway controller** This aggregates communication from the light controllers and backhauls data to a central management platform. Building management personnel can remotely monitor their lighting networks and analyze performance dashboards in real-time.



## How Casambi can help

Casambi offers a wireless communication solution that caters well to today's industrial facilities – by directly answering their need for powerful lighting control while tapping into further energy savings with sensors, switches, and other devices from the Casambi ecosystem.

Casambi is a leading producer of wireless lighting control systems, using technology based on Bluetooth Low Energy. With Casambi, it is possible to create a streamlined, automated, and super-easy-to-control lighting experience by bringing a whole plethora of electronics in on the action from luminaires to sensors, drivers to switches.

When lighting designers set out on a mission to create the ultimate connected lighting experience, Casambi ensures their projects deliver. Casambi's technology and services provide designers with a framework to wirelessly link devices together enabling the end-user to create a personalized smart lighting ecosystem.

Casambi's technology can be integrated into anything from individual lighting fixture controls to industrial-scale solutions with cloud-based remote control, monitoring, and data logging. Hundreds of third-party ecosystem providers already enjoy a dynamic user experience, excellent reliability, and unparalleled performance.

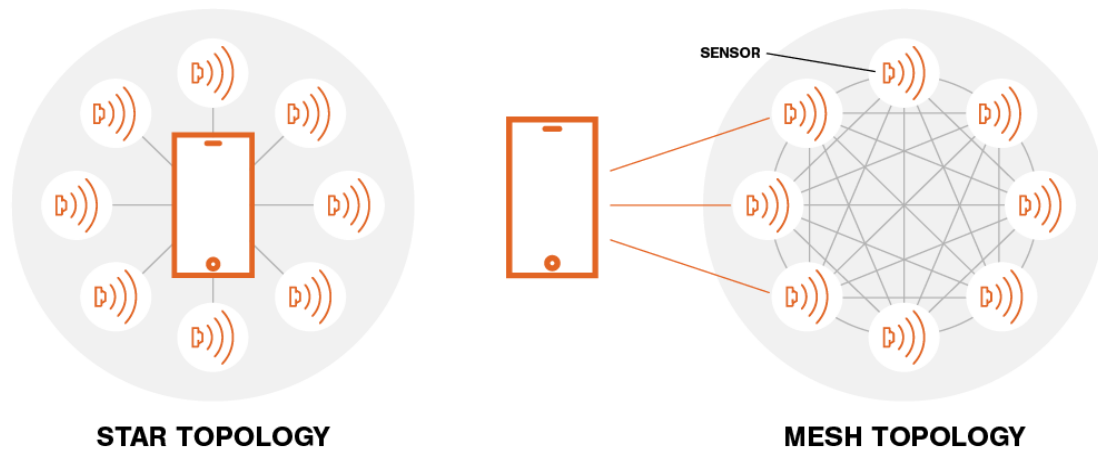
Casambi's technology forms a mesh network ('Casambi Mesh'), which enables encrypted node-to-node communication inside a lighting network. The Bluetooth Low Energy protocol enables communication between a mobile device (or the control device) and the Casambi platform. Bluetooth Low Energy is the most popular and reliable low power radio technology found in all modern smartphones, tablets, and smartwatches today.

Bluetooth Low Energy was conceived and developed at the Nokia Research Center where the founders of Casambi worked. That's why Casambi has had the unique advantage of realizing the full potential of Bluetooth Low Energy early on. Casambi started the development of the solution before there were any Bluetooth Low Energy devices on the market. Growth forecasts predict that more than six billion Bluetooth-enabled devices will ship annually by 2025. Furthermore, Bluetooth Low Energy is projected to have a decisive impact on the market with 96% of all Bluetooth-enabled devices forecast to include Low Energy by the same year.

## What is a Mesh Network?

Mesh networking is essentially a low-latency, low-power mesh network protocol, which in layman's terms translates to a super-fast, battery life-extending, and highly reliable connection.

Mesh networks are self-healing: If one smart device in the network suddenly becomes unavailable, in a mesh network data is automatically rerouted to prevent a connection drop. Mesh networks enjoy strength in numbers: Unlike star topologies, mesh networks expand automatically as more devices are added to them. They can scale up to hundreds of devices without needing a central hub to connect them.



All nodes communicate via radio signals and the mesh topology connects the many nodes ensuring that data has multiple routes to its destination. If one device goes offline, the communication can continue without any interruptions because every single node has the same intelligence as other nodes throughout the network. In other words, if a device goes offline and comes back online again, it automatically and swiftly obtains and downloads from its closest neighbors all the information that it needs to function correctly inside the network. This makes the network robust and self-healing.

There is an abundance of popular mesh networking standards available today to add wireless connectivity to IoT products. Each has different technical strengths, performance characteristics related to throughput, latency, and the ways in which they are taken into use. Casambi, Bluetooth Low Energy, Zigbee, Thread are all mesh networks. But the real efficiency lies in how you set up the network, how it operates, and how interoperable it is.

## Why Choose Casambi?

It can be argued that Casambi is the only truly interoperable and completely scalable, cost-effective solution that is available for wireless lighting controls today.



## Open Ecosystem Architecture

Casambi's open ecosystem architecture is a generation ahead of the proprietary legacy systems currently on the market. Casambi is at the core of an entire ecosystem of products. All of the company's native products and all of its partners' Casambi Ready products are 100% compatible with each other. The technology is also integrated into fixtures, drivers, switches, sensors, and a diverse collection of modules.

Casambi collaborates with a vast number of leading luminaire, driver, LED board, LED lamp, and lighting control module manufacturers. Currently, there are 1000+ (and counting!) Casambi-enabled products available.

## Extend DALI systems with wireless Casambi networks

With Casambi's Wireless DALI Gateway, wired installations can be easily expanded wirelessly, making Casambi the ideal solution for renovations or extensions. In this scenario, one can enjoy all the benefits and flexibility conferred by wireless Casambi networks and still keep all the DALI functions and controls in use.

## Casambi CBU Modules

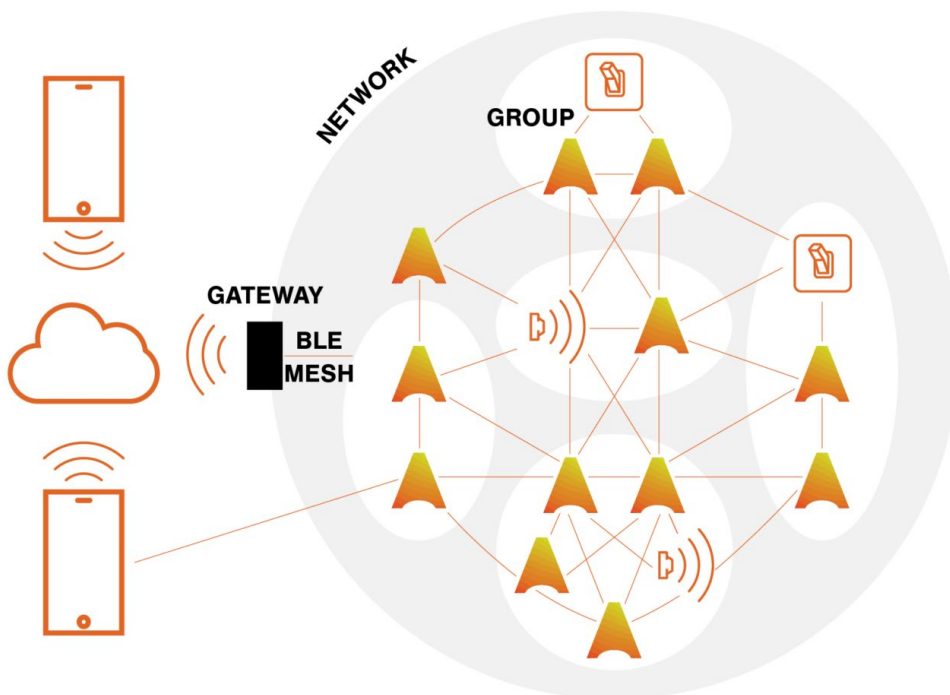
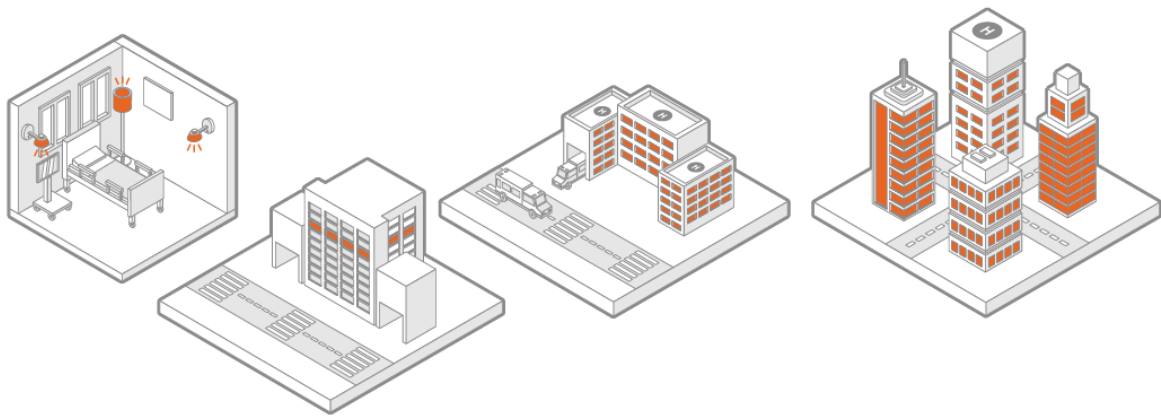
Casambi CBU modules or Casambi enabled drivers can convert a large multitude of non-wireless luminaires into wireless (1-10V, 0-10V, DALI, TED-LR,...)

There are two options for adding Casambi functionality to luminaires:

- **Stage 1 – Option 1:** Select a “Casambi Ready” luminaire from our ecosystem partners, which ensures out-of-the-box interoperability in terms of connectivity and performance.
- **Stage 1 – Option 2:** Luminaires with integral drivers, decorative fixtures with LED lamps, or other devices can gain Casambi connectivity using CBU devices.
- **Stage 2:** Use “Casambi Ready” switches and sensors with wireless mesh functionality to increase the interaction options and connectivity of your network. Or use Casambi CBUs to integrate sensors and switches to the network.
- **Stage 3:** Commission and program the lighting network using the Casambi lighting control application.

## Scalability

To control a basic single room lighting network, all that is required is a suite of luminaires, switches, or sensors that have wireless connectivity. And a mobile device for commissioning and setup. Within the Casambi app, it is possible to create luminaire groups within a network, and then create multiple networks that can all link together. A Casambi network consists of up to 250 units depending on the network mode, and an endless number of networks can be created and used in a single site, giving you endless possibilities to scale up in the future. From a single room, it is easy and cost-effective to upscale to site-level functionality and then expand to outdoor applications. This is what differentiates Casambi from other solution providers today. The advent of wireless lighting control enables lighting designers to expand from the use of discrete, isolated products to product systems and from there to systems of systems that all link together.



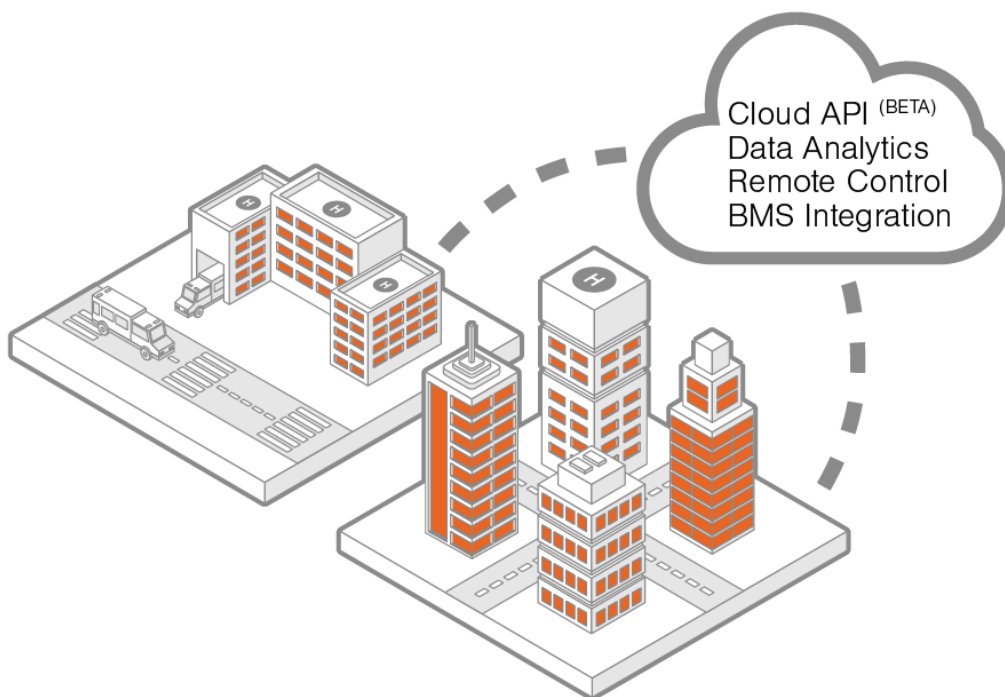
## Flexibility

Because the need for hardwiring has been eliminated, any late additions or changes to lighting installations can be easily implemented in the app. It is possible to add or remove luminaires, add new functionality and new scenes at any time. It is all done in the software. From programming complex functionality, including data analytics, to remote control of site facilities and integration with building management systems, the possibilities are boundless.

The Casambi Cloud API allows software developers to integrate with BMS and in doing so, opening the doors to remote monitoring of Casambi networks, including access to sensor, diagnostics, and usage data. It consists of Rest API & Websocket services, and all received data is in human readable JSON format.

With the Casambi Extension Interface, any sensor information, such as humidity and temperature levels or dangerous gas leaks, can be collected and processed for the safety or the efficiency of your facilities.

Certain BMS have modules with relay outputs which can then be hardwired directly to a Casambi module configured with a switch input. When the relay in the BMS triggers it automatically, it calls the Casambi device to trigger a certain action in the Casambi network.



## Interoperability

As alluded to in a previous chapter, the activities of different IoT alliances and industry groups have created a lot of discussion about competing standards. By and large, nobody wants to take a bet on any single standard approach for fear of incorrectly hedging their bets on a solution that might become obsolete in years to come.

### Interoperability relies on four things:

- **Silicon:** BLE SoC (System-on-Chip)
- **Firmware:** Complex software with mesh, security and most of the lighting control functionality
- **Software:** Full-featured lighting control application
- **Control devices:** LED-drivers, Sensors, Switches

The control devices make up an ecosystem – the LED drivers, luminaires, sensors, switches. However, the chip inside the connected device limits its physical abilities. The firmware that provides the low-level control for a device's specific hardware caps its capabilities and maintains security. The end-user application (the software to configure lighting) dictates the user experience, the interfaces, how to set up a network, and how the user interacts with their network.

In a standard-based ecosystem, the chips that go inside the devices deployed in a network generally come from multiple vendors. Although they may run on a standardized protocol that is intended to enable the same communication, all the chips are different. They likely operate on different runtime resources. They likely have different limitations.

When working with multiple vendors, it is important to be aware of the pitfall of having multiple versions of the firmware within a network. The whole system will be limited by the capabilities of the weakest/oldest device in use within the ecosystem.

Conversely, in a proprietary system, everything comes from one single vendor, so all resources are the same. However, in this scenario, a lighting planner may feel extremely limited when it comes to picking the luminaires, the drivers, sensors, or switches from one vendor to make sure everything works seamlessly together.

Casambi brings together the best of these two worlds. To coin an analogy, it is like an exclusive party, to which everyone is invited. The chip and the firmware come from the same vendor, which is Casambi. This guarantees that the physical infrastructure inside all control devices is the same. A specifier has the freedom to choose the control devices from an extensive list of vendors.

Casambi remotely and safely updates devices in the field with the latest software and firmware. Over-the-Air programming allows Casambi to push new software features and additional functionality out to the entire fleet of installed devices at once.

	Standards-based Ecosystems	CASAMBI	Proprietary Systems
Silicon, BLE SoC	Multiple Vendors	One Vendor	One Vendor
Firmware	Multiple Vendors	One Vendor	One Vendor
Control Devices	Multiple Vendors	Multiple Vendors	One Vendor

## Security & robustness

Although communication range in radio technology may ultimately vary depending on the environment in which it operates, the typical range for wireless connectivity is 30 meters indoors, and 50 meters for outdoors. Bluetooth 5, compared to its predecessor Bluetooth 4, quadruples the wireless range from 50 up to 200 meters in free air.

With high antenna performance, and every node endowed with intelligence, all communication inside a Casambi mesh network is robust and meets the demands of all challenging industrial environments.

Communication between mobile devices and nodes is fully encrypted, and a five-level approach for security and authentication means that all data transmitted within a Casambi network is protected and safe.

All nodes in a Casambi mesh network carry a backup of the entire system, which speeds up the communication and makes it all the more stronger.

## Benefits at every step of an industrial lighting project

- Save up to 40% on energy bills for industrial facilities using a multiple control strategy combining occupancy detection and daylight harvesting. With Casambi, any existing lighting installation can be upgraded to include occupancy and daylight sensors.
- Save time and money by replacing the need for rewiring with wireless data communication. This enables rapid commissioning via the Casambi app.
- Eliminate the need for patrols and the cost of expensive maintenance call outs with remote monitoring, automated fault detection, testing and predictive maintenance.
- Increase safety with wireless emergency lighting. Casambi and Tridonic have partnered to produce a wireless emergency system, which enables automated testing and reporting
- Save time and costs on the re-commissioning of networks in busy buildings.
- Casambi's intuitive design makes commissioning tasks so simple that they can be easily handled by facility managers.

# Casambi X DALI

Casambi offers users unparalleled flexibility with wireless, wired, and hybrid options. Whether leveraging entirely wireless capabilities or opting for traditionally trusted wired solutions, users can effortlessly mix and match to tailor lighting networks to specific project requirements.

A hybrid solution might entail control of luminaires through wired DALI means alongside wireless Casambi Ecosystem products in the same lighting controls system. This adaptability ensures that Casambi remains applicable across diverse settings, empowering users to choose the most fitting configuration for their needs.

The latest addition to Casambi's DALI integration options, Salvador seamlessly integrates wired DALI drivers into the Casambi system, with a single unit capable of controlling up to 64 DALI drivers. DALI luminaires, when incorporated, will appear in the Casambi network as virtual luminaires, where they are programmed and controlled in the same way as Casambi Ready devices via the Casambi App. Salvador enables the extension of existing DALI networks and the creation of hybrid networks that consist of both Casambi Ready and DALI devices. Multiple Salvadors that are controlling DALI luminaires can be wirelessly connected to form a single Casambi mesh network. Notably, this product supports industry standards such as DALI D4i, DALI DT6, and DALI DT8. Additionally, Salvador features an integrated power supply, an internal Real-time clock (RTC) with backup energy storage, and cable strain relief to facilitate a smooth installation process.

## Wireless emergency lighting

Modern emergency lighting systems must meet strict maintenance and testing requirements, including advanced control and communication functions.

There are several wireless emergency lighting solutions based on Casambi technology. These systems support DALI DT1 standard devices, meaning reliable interoperability with DALI self-contained emergency control gear, and enable wireless communication without the need for additional hardware or traditional DALI wiring. Emergency devices are easily paired using the Casambi App, allowing for an easy wireless upgrade for existing luminaires without a change of layout. Users can easily view the luminaires' signal strength and identify emergency devices from within the Casambi App.

These solutions provide automatic testing of individual luminaires, standard-compliant logs that available to download or access from cloud, and central monitoring via iPad or PC-based graphical user interfaces.

For more information on the wireless emergency systems based on Casambi technology, please refer to the Ecosystem section inside Casambi website.

## Case Studies

### **Safran Transmission** saves energy while improving working conditions

*"Thanks to the modernization of lighting, we were able to reduce carbon dioxide emissions by about 240 tons per year, and at the same time we managed to reduce costs due to electricity consumption by about 20%"*

Piotr Juszczak – Maintenance manager , Safran Transmission Systems



Safran Transmission Systems Poland is an aviation industry leader, having manufactured aircraft engine components since 2001. The company cooperates with over thirty suppliers and the production process takes place in three large factories located in Poland. When Safran decided to update its lighting stock, Luxon LED and Casambi were chosen for the luminaires and wireless lighting control, respectively.

As the factory is in use around the clock, it was not possible to conduct any installations that would disturb ongoing operations, and all new luminaires had to be installed using the existing wiring system. Aside from improving working conditions, the client was looking to optimize energy consumption during operating hours.

There are now 1540 high-efficiency luminaires in place with high IP-class and low glare rating. Each fixture has a Casambi CBU-ASD control unit in an IP67 box to ensure good communication. In addition, each luminaire is controlled individually, and it is possible to make easy changes to the lighting in specific areas as per production requirements – thus improving working conditions. Additionally, sixteen High Bay Wide Detection sensors from Danlers have also been installed for daylight management.

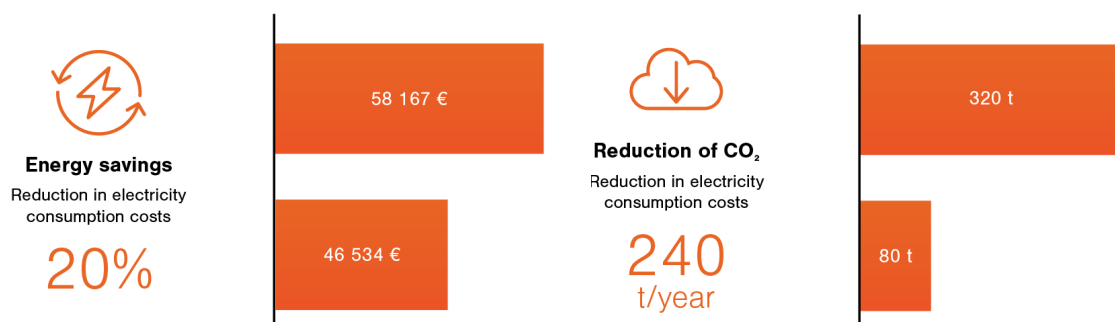
Installation costs were kept to a minimum because no additional signal cable had to be installed in the old cable ducts. Due to easy installation procedures, which didn't halt factory production, project costs were also kept low. Since project completion, Safran Transmission Systems has reported an energy reduction of 20 %, a 240 ton/year reduction of Co2, and a 300% improvement in light intensity.

### What was installed:

- Luxon Industrial 73W, 4000K 490 pcs
- Luxon Ultima LED 54W, 4000K 525 pcs
- Luxon Ultima LED 84W, 4000K 525 pcs
- Danlers CBU HBWD sensors 16 pcs
- Number of Casambi nodes: 1556

### Customer benefits:

- 20% reduction in energy consumption
- 240 tons of CO2 emissions saved annually
- A wireless control system that enables the user to adjust the parameters of the luminaires
- A 1:1 replacement of the luminaires without changing the existing electrical installation
- 300% improvement in light intensity
- Lower Unified Glare Rating (UGR) and improved working conditions
- Task tuning by controlling each luminaire individually and changing the levels of lighting in specific areas
- Non-disruptive installation





**Goldbeck** verifies Casambi performance for industrial applications at own facility

*"Casambi seemed very interesting to us, so we decided to start a project in one of our plants, where we can do different tests over a long time and where we could evaluate costs, maintenance, and reliability. We concluded that it is ready for industrial use. It can be easily controlled and maintained by only a facility manager – no special electrician is needed. And even if it's simple to understand and to learn how to program via the app, you can realize advanced lighting control solutions with it. Casambi is ready for industrial use and Goldbeck can offer Casambi to its customers as the new lighting control standard in industrial buildings"*

Jonathan Dertenkötter, Goldbeck Product Development Electrical Engineering



Goldbeck builds future-oriented commercial properties across Europe, and as a company is celebrated for its fast-building process and sustainable, intelligent building technologies. With 8000 employees in more than 70 locations, Goldbeck provides a full scope of services from design and construction to full lifecycle support during operation.

Casambi caught Goldbeck's attention as a lighting control system that they could standardize into their planning strategies, so they tried it out in one of their plants (in Bielefeld, Germany). To generate and develop new intelligent building solutions, Goldbeck vigorously tests all proposed solutions to evaluate their reliability, ease of use/maintenance and cost efficiency. Herewith, they wanted to put Casambi's control system through its paces too. They conducted tests to measure the overall energy savings, the range of the nodes, and led performance and field analyses of not only Casambi-native products but also those of third-party companies using Casambi technology.

The company was pleased with the results. They were particularly happy to learn that their typically-used control modes, like presence-controlled switching in the shelf corridors or daylight harvesting in the production/logistics area, could be implemented. It was calculated that should Casambi control be implemented across the whole warehouse space, significant energy savings could be achieved – to the tune of 58% annually. Consequently, Goldbeck will introduce the Casambi system internally.

**Customer benefits:**

- 58% drop in energy consumption
- Ability to perform lighting control tasks with ease – safely, effectively and efficiently
- Boundless advanced lighting control settings available via the Casambi App
- Improved working conditions with bespoke smart lighting scenes and daylight harvesting

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[casambi.com](https://casambi.com)