# Autonomous Sensor Network for Smart Street Lighting

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*CSEM has developed the Illumaction platform, a smart, autonomous and wirelessly networked platform for smart lighting applications. This platform forms the core of the demonstrator of an autonomous cooperative public-private lighting system, particularly well-suited to deal with complex urban environments.*

Automatic light management in smart cities, or "smart lighting", is one of the most popular applications with respect to urban automation. Wireless communication, robustness, reactivity, and autonomy are key features of these applications, in particular for the sensors that are distributed in the surrounding environment to detect the various events. Partnering with the City of Neuchâtel, CSEM has developed a platform, based on the WiseMAC protocol, for interconnecting many such sensors and nodes dedicated to the control of the public and the private lighting elements in a wireless, robust, reactive, and autonomous network.

Artificial lighting is important for security, safety, comfort, etc. at night and may be during the day as well. Public and private lighting (e.g. commercial displays) are sometimes redundant. Usually, they are operated independently, which prevents them from cooperating. By fitting networked sensors (able to detect and report events and conditions) and bulb controllers into the lighting systems, it is possible to foster such cooperation, thus providing a better service, preserving security, safety and comfort. Although minimal in financial terms, energy savings are real and represent a great example and motivation to the public. As an added benefit, companion functions can be provided, such as energy metering, bulb failure detection, temperature and noise monitoring, crowd and traffic management, etc.

CSEM has developed in the past a number of smart wireless autonomous platforms (under the generic term of WiseNET) and devices, which are now used in various application domains, such as environmental monitoring, structural health monitoring, condition monitoring, home automation, health care, transportation, safety, etc. and more generally in the Internet of Things. WiseNET uses WiseMAC, which is one of the most power efficient wireless communication protocols, while offering mesh networking, self-healing, security and low end-to-end delays. WiseNET can operate in various environments, including, indoor, outdoor, urban or rural areas. In addition, it offers robustness with respect to partial communication failures or wireless link degradation by establishing alternative data transmission routes.

WiseNET forms the basis for the Illumaction system, which measures the light intensity and motion at several geographical points and sends the data to the local bulb controller, which embeds the logic for adjusting its intensity. As such, the system autonomously controls the lighting elements in complete autonomy (blue boxes shown on Figure 1). The mesh capability of the network allows for fully scalable collaboration over areas of any size, by conveying sensor data to any point in the network (Figure 1 shows one communication configuration, which can change over time). This allows, for example, for the extension of the lighted area around a person by involving remote bulbs, thus improving his/her comfort, security and safety.

The sensor data can optionally be reported to the central management process through an internet gateway (pink box shown on Figure 1), extending the system, e.g. to the entire city.

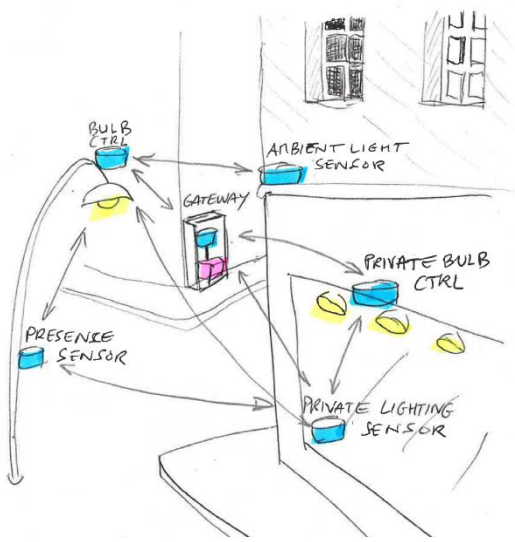


*Figure 1: Example of CSEM smart lighting deployment.*

The Illumaction demonstrator shown in Figure 2 is made of a bulb controller driving a LED panel through a 0-10 V D/A dimming interface (top right), an ambient light sensor (bottom right), and a relay between the sensor and the controller (middle right).

*Figure 2: Example of CSEM smart lighting deployment.*

The demonstration has proven the autonomous behavior of the system and its performance in terms of reliability and reactivity. The control loop, triggered by an induced change of the ambient light, followed by the transmission and the processing of the sensor value, ending with the modification of the D/A output takes less than a second. The power consumption of the sensors and the relays allows for several years of operations on a set of AA batteries. The mains power supply powers the LED panel and the bulb controller.