Streetlight controls for smart cities based on IoT Technology

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1. Introduction

Today, approximately 50% of the world's population lives in urban environments. By 2050, an estimated 70% will live in these areas, putting cities under even greater pressure to provide the necessary infrastructure and services to engage its citizens and help the private sector thrive. A fervent advocate that cities, industry and citizens must work together to help cities wisely navigate the transition to smart technology.

Smart technologies can help cities meet these challenges, and they are already enabling the next wave of public investment. It all starts with data. Cities, in all their complexity and scope, generate oceans of it. Finding the insights in all that data helps municipal governments respond to fluid situations, allocate resources wisely, and plan for the future. Furthermore, putting real-time information into the hands of individuals and companies empowers them to make better decisions and play a more active role in shaping the city's overall performance. As cities get smarter, they become more livable and more responsive—and today we are seeing only a glimpse of what technology could eventually do in the urban environment.

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Streetlight poles give municipalities various benefits within thei smart city implementation strategy. They are placed across all the city, they offer electricity to tap off and they provide a perfect coverage of the area as they are mounted high enough and still can give detail view.

Apart of using the street light poles to gather information like video surveillance or wifi deployment in to city environments, the management of lighting is vital in providing the service delivery to residents as expected by the community. It adds to the well-being of citizens within a city environment. It increases safety and is a crime deterrent.

2. City Management System

2.1. General Description

Street lighting management systems should be easily integrated into the smart city platform and therefore should be based on Open Standards, and therefore can interact with larger smart city platforms. The system should provide not only be a high performing remote lighting management system, it should also exchange data or interoperate with neighbouring systems such as traffic management sensors, environmental monitoring systems or security devices.

One of the fundamentals of IoT (Internet of Things) is that the devices intended to be connected to a larger network communication platform have to be `addressable' in a similar way. The structure of the address which is attributed to this generation of IoT luminaire controllers is called IPv6. This is very similar to what we already use as IP addresses in each connected device (referred to IPv4) but it already conforms to the upgraded technology called IPv6. The difference between the two, is that the IPv6 can cater for far more connected devices than the current IPv4 can do.

	IPv4	IPv6
Deployed	1981	1999
Address Size	32-bits	128-bits
Address Format	Dotted Decimal: 192.168.27.134	Hex: 3FFE:F200:234:AB00: 123:4567:8901:ABCD
Number of Addresses	2^{32} = 4,294,967,296	2^{128} = 340,282,366,920,938,463, 463,374,607,431,768,211,456

Figure 1 Difference between IPv4 and IPv6 addressing

This method of addressing devices can generate an almost unlimited number of unique combinations to connect non-traditional components to the Internet or computer network. The City Management System is not a stand-alone `silo type' system, but future oriented and open to 3rd party integration.

2.2. Set-Up

The implementation of the City Management System should be as simplified as possible to avoid extensive set-up and commissioning time and create an sort of dependency to a certain supplier or service provider. The use of a built-in GPS antenna and an intelligent auto-commissioning process would convert a system into a real Plug and Play solution which does not require any intervention from the installer or contractor, nor any segment controllers or gateways. There should be no need for field recording, scanning or annual mapping. It should also offer location detection changes to offer a more accurate management, e.g. following maintenance schedule and correctness of work done on site.

The advantage of a luminaire controller mounted on a universal socket like the most common used 7 pin ANSI - NEMA socket would offer various advantages to council as all the hardware and software could be integrated on every type of luminaire as long as it can offer a NEMA socket. Even existing luminaires could be therefore retrofitted. This will avoid the need for the commissioning engineer to manually record the position of each luminaire.

Figure 2 Luminaire controller fitted on standard NEMA socket

2.3. Hybrid Architecture

The heart of the City Management System shall be a full hybrid concept. It should consist of a strong local mesh network between the luminaires and the sensors and a robust cellular backhaul communication with the system servers.

The RF communication network between the local `actors' enables an instantaneous reaction from event triggers like movement or presence detection. This is a key element in creating a real adaptive lighting scheme.

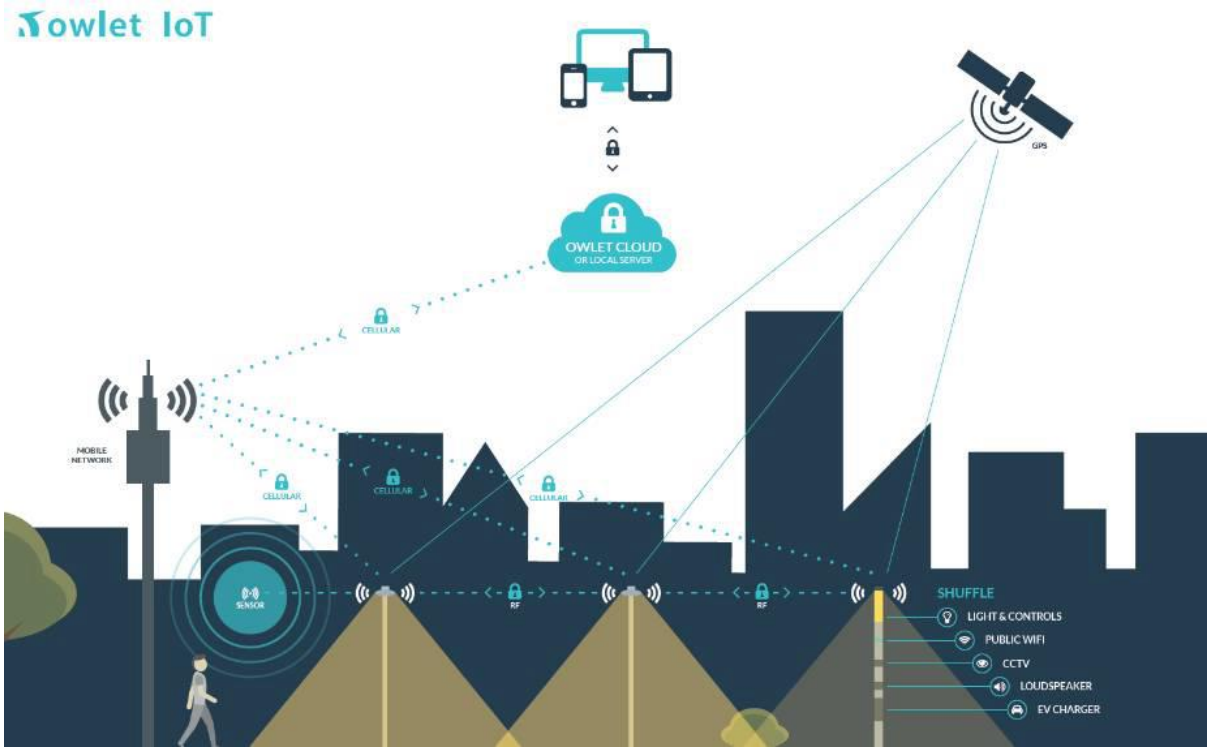

Figure 3 Hybrid communication system enables flexibility, immediate response and a robust communication structure

2.4. Sensor Compatibility

Different types of sensors like PIR and radars should be easily integrated and connected directly to the luminaire controller. This will simplify the installation as the luminaire controller will provide for the required power supply to the sensor and can read of the sensor input. Sensors can be integrated into the luminaires, fixed to the pole or remotely installed. With this matrix concept, one sensor can be linked to multiple luminaires and vice versa, each luminaire can be linked to multiple sensor inputs. Switching the light levels from the lower `idle' state to the higher `event' state during the night, increases the visual performance as well as the level of comfort while maintaining or even increasing the potential energy reduction.

2.5. Asset Management

With a rapid change of technology like we experience with LED lighting it will become more and more of a chlanange for a council to manage and control their assets in the field. It will be almost impossible to keep track of what has been installed at various point in the city environment without a "life" read-out of your asset register. If this is not available, the council will have major difficulties to understand which luminaire type has to be deployed in case of a luminaire failing or requires replacement. The luminaire controller shall incorporate a component to capture the characteristics of the luminaire and store it in an RFID label, to which it is attached. This luminaire data and the precise luminaire position provided by the GPS feature, determines the luminaire light profile for the given location. Furthermore, it serves as the basis for an active luminaire asset management system.

Figure 4 Asset management functionality using a RFID tag

2.6. Energy Consumption

To be able to offer the most accurate measurement of data to be used to calculate and monitor the utility providers bill, the nodes or luminaire controllers should incorporate a built-in utility grade energy meter that offers the highest metering accuracy (<1% for the complete dimming range).

2.7. Safe Fall Back scenarios

One of the highest risk scenarios within a smart city environment is the cyber encryption the system should provide. The system has to be fitted with the latest cyber security feature and should be continuously updated to match the latest available standards. As safety is a primary objective, multiple technologies (e.g. AES encryption) ensure that the City Management System is switched on and off in complete security. There are the switching and dimming commands provided by the profile in the system as well as the astronomical clock and built-in photocell to avoid a complete blackout at night.

2.8. Web Based Application

The City Management System shall be web-based. This means that the software does not have to be downloaded onto one or multiple computers. The application can be accessed by means of a username and password from every computer, tablet or mobile device connected to the internet. Each user is assigned a specific access to view or modify the parameters. All security measures have been taken to protect the system from any kind of intrusion.

2.9. Intuitive User Interface

To operate the system efficiently the Graphical User Interface (GUI) shall be using the latest web-based application tools. Each user should be able to organise his/her dashboard in such a way that the most relevant topics or parameters appear first. The GUI should offer OpenStreetMaps and in combination with a good icon design (shape and colour), it should provide a great overall view at a glance. In addition, the traditional reports regarding the status of the installation as well as the monitoring can be organised to suit the individual customers' needs.

The City Management System should utilize the 'push' principle to retrieve data. This method considerably reduces the reaction time of the system in case the status of the luminaire controller has changed.

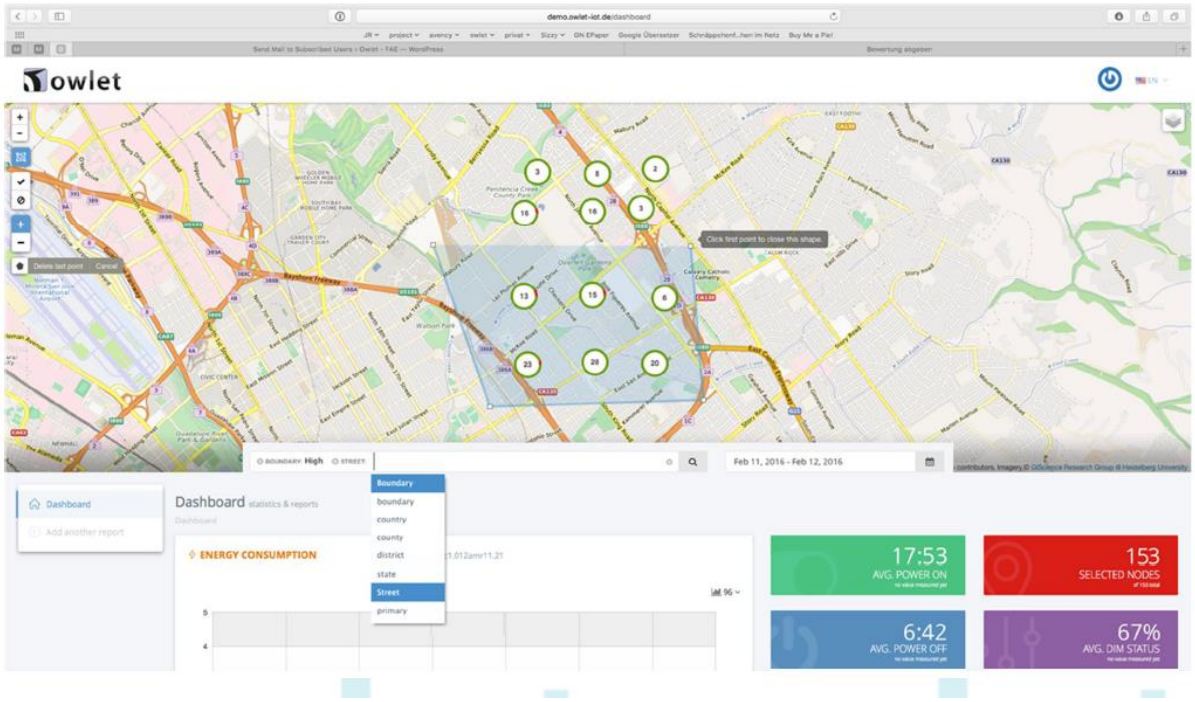

Figure 5 Web based interface offering various information

2.10. Operational Benefits

The City Management System has the capacity to implement, adapt and reproduce lighting profiles and driver settings, which are typical for public lighting networks. It further offers immediate alarm reports on various trigger points, e.g. cable theft, power outage or luminaire failure reports. The reports can be sent to various stakeholders and therefore immediate response teams can be deployed instantly to prevent further damage or avoid service delivery complaints.

3. Conclusion

“Smart City” is the buzz term in city future strategy discussions. The challenge is how and when to implement such strategy. The various platforms relating to the different infrastructure requirements are almost impossible to implement at the same time all at once. Therefore, individual platforms can be integrated individually and at steps as per the available budget levels available and they should be implemented and interchangeable with other platforms using open communication platforms and easy installation and commissioning processes. This paper should explain and enlighten the city council members, in relation to the streetlighting management, on what the minimum requirements should be and why they are important. Following this technical process, the successful system integration and the efficient deployment of a street lighting management should result in great benefits to all stakeholders.