Smart Street Lighting Controls '101'

May 2019

KEY POINTS:

- An LED street lighting upgrade, when accompanied by **smart controls** technology, can offer:
    - Dynamic control of lighting levels
    - Dramatically improved lighting service levels
    - Reduced maintenance costs
    - Additional energy savings
    - Reduced light pollution
    - Metered energy consumption of each luminaire
    - Improved asset management capabilities while speeding up installation times for new luminaires
- While adoption has been slower in Australia, smart street lighting controls are increasingly being deployed in major lighting replacement programs around the world.
- Smart street lighting control systems can be described as a set of three interacting component levels: A Central Management System (CMS), network communications infrastructure and field devices (e.g. plug-in smart control components that sit on the luminaire both controlling its operation and communicating with the network).
- Smart street lighting controls and the supporting communications infrastructure is increasingly recognised as a viable first stage use-case and enabling platform for other smart city infrastructure.

Adding intelligence and communications capabilities to the devices that control street lights offers a wide range of benefits. As identified in Sections 5.9 – 5.13 of the SLSC Roadmap, a street lighting LED roll out, when accompanied by smart controls technology, can:

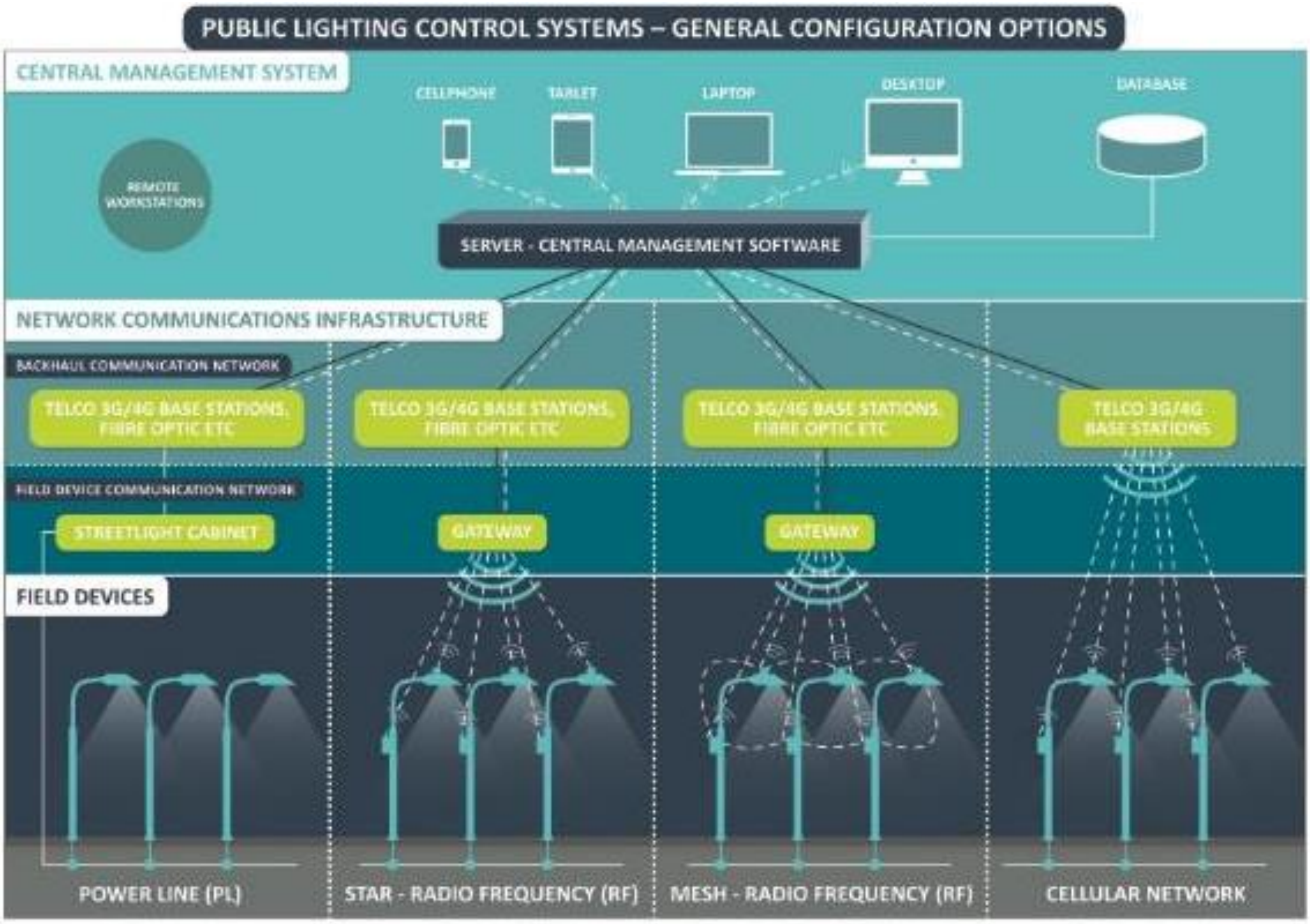
- Improve the lighting service by offering dynamic control of lighting levels in response to the time of night, traffic volumes, weather sensors and environmental or other guidelines
- Dramatically improve service levels by remotely monitoring and reporting faults
- Reduce maintenance costs by eliminating the need for night patrols and allowing maintenance planning to be optimised
- Save additional energy by enabling constant light output controls, allowing lighting to be dimmed in the off-peak period and enabling excess lighting to be trimmed. The 2016 SLSC Roadmap estimated the additional energy savings from smart controls at typically 10-20% (over and above the average 50%+ energy savings from an LED upgrade). More recently, Navigant's Research

Leaderboard: Smart Street Lighting 2018 estimated the additional energy savings of smart controls at typically 30%. Consideration should also be given at the time of assessment to the modest additional energy used by such systems (generally 1-2W per field device and some energy for a communication gateway needed typically every 200-25,000 luminaires to connect field devices to the Central Management System).

- Reduce light pollution by enabling traffic activity related switching, dimming or trimming over nightly or seasonal cycles.
- Meter actual energy consumption of each luminaire using in-built metering chips with metering-grade accuracy levels (importantly, this metering capability is not recognised under the National Electricity Market approach to metrology as at mid-2019).
- Improve asset management capabilities by allowing auto-population of asset registers with full inventory information about a newly connected luminaire (including asset information stored in the power supply and GPS location). Storing of asset management information in the power supply results in greatly improved inventory accuracy and reduced installation times for new luminaires. The use of GPS chips offers the highest levels of accurate short and long-term asset location information and validation.

For the above reasons, most major LED upgrades around the world since about 2016 have included smart controls. Adoption in Australia has been slower due to split incentives and a number of regulatory barriers including the inability at present to recognise the energy savings of such systems for utility-owned lighting.

Smart street lighting control systems can be described as a set of three interacting component levels: A Central Management System (CMS), network communications infrastructure and field devices (e.g., smart controls devices on luminaires). These are further described in the figure and sections below.



Source: IPWEA SLSC Programme Model Public Lighting Controls Specification

Central Management System

A Central Management System (CMS) is software that runs on a central computer (in the cloud or an on-premises server) that typically delivers a secure web-based interface on a range of desktop and mobile devices. A street lighting CMS collects, stores and displays street lighting operational information to authorised users including whether luminaires are working, their asset information and how much energy they have used. It allows the user to set starting and stopping times, dimming levels and produce reports on faults, fault repair times, energy consumption and other operating information. It also enables export of this information to third party software such as asset management systems, energy billing systems, GIS systems and Smart City platforms.

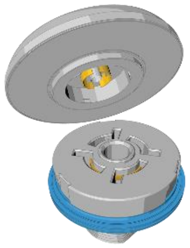
Network Communications Infrastructure

As illustrated in the figure above, there are a wide variety of communications methods that can be used to connect smart street lighting controls to a CMS. The most relevant for smart street lighting controls are summarised in the table below:

Communications Technology	Unobstructed Operational Range	Advantages/ Disadvantages	Relative Cost
Fibre/microwave (High Bandwidth)	30-200m	Very high data rates can be provided but far in excess of that needed for lighting controls. More appropriate for higher bandwidth applications such as HD CCTV and Wi-Fi.	$$$$$
5G (when available) (High Bandwidth)	Unclear	Emerging network with very high data rates; large expected variety of uses including lighting controls.	Unclear
LTE, Cat M1 & NB-IoT (High, Med & Med-Low Bandwidth respectively)	Up to 25 km	Utilises current mobile telecommunications infrastructure with Telstra the first to provide widespread Cat M1 and NB-IoT coverage and Signify the first to offer field devices. Other suppliers such as Telematics and GE now offer compatible nodes.	$$$
LoRaWAN (Low-Med Bandwidth)	Up to 15 km	General IoT star network with long range, lower data rates, very low power needs for extended battery life. Leading network operators in Australia include Meshed, NNNCo and GeoWAN. Device suppliers include Flashnet, Urbana, Telematics and Lucy Zodion.	$$
Mesh Networks (Med Bandwidth)	Up to 15 km depending on technology	IoT mesh networks using Wi-SUN, Zigbee, Wirepas and other protocols. Itron (Silver Spring Networks) is a prominent provider using Wi-SUN IEEE 802.15.4g mesh network which supports a variety of partner devices within the eco- system	$$
Proprietary Street Lighting Networks (Low-Med Bandwidth)	Up to 15 km depending on technology	Low-power, long-range mesh and star networks using public and private spectrum. Leading network/device suppliers include Telematics, Telensa, Traffic Technologies, VRT, Dimonoff and Lucy Zodion.	$$
Sigfox (Low Bandwidth)	Up to 40km	Low power / low data rate sensors; Network provider in Australia is Thinxtra with Flashnet as a device supplier.	$$

Field Devices

Most smart street lighting controls deployed to date globally and in ANZ have been those fitting into a NEMA / ANSI C136.41 7-contact receptacle (see figure). This receptacle is a modified version of the traditional 3-pin photocell receptacle that has been widely used around the world in public lighting with traditional photocells for some decades. The addition of four communication contacts to the traditional NEMA / ANSI receptacle has allowed smart street lighting controls to directly communicate with and control the luminaire power supply.



An emerging option is the smaller and low power (24V DC) Zhaga Book 18 interface that can accommodate both smart street lighting controls and emerging smart city sensors (see next section).

Smart City Devices

Smart street lighting controls and the supporting communications infrastructure is increasingly recognised as commercially viable and an enabling platform for other smart city infrastructure. In short, once the communications networks are installed, they are able to support a range of other devices in the public domain at low marginal cost.

The communications networks may be able to support activity sensors, traffic/pedestrian counters, environmental sensors, metering, flood level indicators, lead detector, security sensors, asset locations devices and many other smart city devices.

A rapidly emerging development is the ability of street lights to directly support additional smart city devices on the luminaires. While developments in this area are moving quickly, early deployments have tended to have a NEMA / ANSI C136.41 7-contact receptacle to enable connection of a smart street lighting controller and an additional Zhaga Book 18 compliant interface to support an additional smart city sensor as shown in the adjacent figure. Supporting both types of receptacles requires a different type of power supply with Signify's SR power supplies being the first to market and others becoming available.

MORE READING:

1. IPWEA SLSC Roadmap
2. IPWEA SLSC Model Public Lighting Controls Specification
3. Zhaga Book 18, Zhaga Consortium
4. Turning street lights into a smart city network, IoTHUB