COST-EFFICIENT AND RELIABLE INTERNET OF THINGS CONNECTIVITY FOR SMART LIGHTING

Lighting is one of the most basic human needs with an estimated 12 billion end points in streets, offices, factories, retail locations around the world. Light emitting diodes (LEDs) are transforming lighting by providing substantial energy savings but much greater benefits can be achieving by equipping LEDs with controls and sensors and connecting them to the Internet of Things (IoT). For example, smart street lighting can provide further energy savings by producing only light that is needed when it's needed and can reduce maintenance expenses by automatically reporting when it requires service.

One of the biggest challenges in achieving these benefits is connecting each individual lighting node so that the lighting can be efficiently managed and the lighting infrastructure can serve to extend the IoT. Connectivity solutions for intelligent lighting must provide a total cost of ownership and ease of deployment in keeping with the large and rapidly growing number of endpoints in the smart lighting network. Other critical requirements include high reliability, low energy consumption and low latency. This white paper will provide an overview of smart lighting applications, discuss their special connectivity challenges and provide ideas on how they can be overcome.

THE SMART LIGHTING REVOLUTION

Replacing traditional high pressure sodium street light fixtures with LED lamps provides an immediate energy savings, typically in the range of 50% to 60%, while also providing brighter, whiter light. Adding intelligent controls and connectivity enables the lights to be brightened or dimmed based on the amount of natural lighting or even turned off entirely until an approaching car or pedestrian requires them to be lit. Smart, connected lighting provides additional energy savings of up to 35%, bringing total energy savings up to 80%. Connected outdoor lighting also provides a platform to mount sensors and actuators that can provide additional value such as by monitoring traffic to optimize traffic light timing, tracking utilization of parking spaces, monitoring the street with security cameras and over-lighting the scene of a public safety incident.

Intelligent indoor lighting systems are expected to form the nervous systems of the smart, connected buildings of the future. For example, smart lights may respond to data from wearable devices to help perk up your mood, de-stress you or help you concentrate on the task at hand. Beacons ride along on smart lighting to transmit and receive messages to and from smartphones to communicate with people indoors. A retailer could provide customers who have opted in to their beacon with special offers, product information, or automated checkout. Direction finding devices are being embedded in smart lighting systems to track the location of assets within facilities, guide automated vehicles and robots and enable people to find their way around with indoors GPS.

CONNECTIVITY CHALLENGES

Achieving these and the many other potential benefits of smart lighting requires that millions of lighting devices be connected to the IoT which in turn presents some major challenges. The huge number of lights that needs to be connected demands a cost-effective solution. The costs that must be considered include not just the cost of the modules connecting each light but also the complete networking infrastructure required to connect each endpoint to the Internet, including network design hardware and installation costs. It's also important to consider recurring costs such as software licensing fees. Lighting must often change to adapt to evolving requirements so the cost of adding new nodes plays an important role in the total cost of ownership.

Reliability is another important challenge in lighting applications. The radio environment frequently changes due to factors such as temperature, buildings and other obstacles, and atmospheric conditions. The walls of the building provide additional obstacles that must be overcome when connecting indoor lighting. Energy consumption is a major concern in the majority of lighting applications where the connectivity module needs to be powered either by a battery or by energy harvesting. Latency is important in applications where lighting is controlled by a person that expects an immediate response.

LIGHTING CONNECTIVITY ALTERNATIVES

In a number of smart street lighting applications, connectivity is provided by running a fiber optic cable to each street light. This very expensive approach is typically chosen in applications where small cells that can be leased to cellular access providers ride along on street lights. The high cost of laying cable and the limited demand for small cells makes it possible to justify this approach only in a small number of applications. By the same token, equipping each lighting node with a pricy cellular connection is cost effective only in applications involving a very small number of lighting nodes.

The most common approach in mainstream applications is to use available spectrum such as the industrial, scientific and medical (ISM) radio bands to upload data to gateways. The gateways in turn are typically connected through repeaters or routers to the core network. This approach is considerably less expensive than either running fiber or using cellular connections. But it still requires a relatively large number of gateways – typically one for every ten nodes – which, along with the repeaters and routers, adds considerable cost beyond the modules. Designing, configuring and installing the network is another major expense. Each node is typically designed to communicate only with a single gateway, resulting in a single point of failure that has a negative impact on network reliability.

A NEW APPROACH TO LIGHTING CONNECTIVITY

Wirepas Connectivity for Lighting is a wireless connectivity product optimized for indoor and outdoor lighting that is based on the Wirepas Connectivity protocol. The Wirepas Connectivity protocol is an automated multi-hop mesh network that enables each lighting node to communicate with its neighbor, passing data from device to device until it is finally delivered to a gateway. Each node can send data to multiple devices and to multiple gateways and is itself a possible routing point for any other node. The network automatically balances loads among the gateways and if radio transmissions conditions deteriorate, the network automatically reconfigures itself so that data is sent via routes that bypass the troublesome area.

The individual nodes interact with each other to determine the optimal transmission pathway for each node, eliminating the need for a central network control system. The network nodes cooperatively select the times and channels used for communications, while using all of the available channels in a given band. The devices determine the channels and exact time to communicate with each other in advance, eliminating overhead such as overhearing, idle listening and intranetwork collisions. The connectivity protocol can be configured to optimize the tradeoffs between bandwidth, latency, range and power consumption based on operating parameters that can be changed by network administrators.

REDUCTION IN TOTAL COST OF OWNERSHIP

This approach provides a major reduction in networking infrastructure, design and installation costs compared to conventional networking designs. The ability to pass data from one lighting node to the next greatly reduces the number of gateways required. The number of nodes per gateway can be increased to between 100 and 1000 depending on the application. The gateways are in most cases located at connection points to the core network such as cellular base stations which eliminates the need for routers and repeaters. Installation of and changes to the lighting network are also considerably less expensive using this approach because new lighting nodes are automatically recognized by other nodes and configured into the network. The connectivity solution itself is offered for a one-time royalty payment that does not require any subscription fee.

The new connectivity option also has the advantage of being able to work with any physical layer. Using an open standard radio module instead of a proprietary module often provides a substantial reduction in hardware expenses. Costs typically run $15 to $25 for a proprietary module in volume vs $3.00 to $5.00 for a commercial high volume radio module. As an example, the u-blox NINA-B1 wireless module offers excellent range and as well as low power consumption. It is certified out of the box for a large range of countries worldwide, reducing risk and time to market for customers integrating the module in their devices. NINA-B1 is produced for industrial use in terms of quality, robustness and environmental requirements, providing a good fit for lighting applications.

If a radio transmission problem is experienced, the Wirepas Connectivity for Lighting network will simply reconfigure itself to solve the problem so it delivers 4 nines reliability, a considerable improvement over conventional wireless networks. The new communications platform can be tuned for low energy and this case will provide more than 10 years of battery autonomy for connected sensors and beacons. Or, it can be tuned for latency and in this case it offers sub-5 milliseconds latency per node at 2.4 GHz.

CONCLUSION

Smart, connected lighting provides energy and maintenance savings while increasing the quality of light provided to users. At the same time the smart lighting infrastructure can extend the IoT to deliver a wide range of applications such as environmental sensing, advertising and indoor position locating. The new Wirepas Connectivity for Lighting product substantially reduces total cost of ownership for smart lighting applications by eliminating the need for routers and repeaters, reducing the number of gateways by a factor of 10 to 100, and reducing network planning, field installation and maintenance costs. The new wireless networking platform can also improve network reliability, reduce energy consumption and reduce latency. As a result, Wirepas Connectivity for Lighting provides the ideal solution for connecting outdoor and indoor lighting to the IoT at the lowest possible cost while delivering high levels of performance.