Saving time, energy and lives using ELMS: How to better manage electrical infrastructures

By Jim Frazer

Until the advent of network communication technologies in the 1980s, Electrical Lighting and Management Systems or ELMS and related intelligent networked highway technologies were in the realm of science fiction.

About that time, many leading technology companies realized that they could offer additional product features by accommodating communications with other vendors' products. There was, however, a significant roadblock – no common language was available to facilitate this desired communication.

To address this issue, the National Electrical Manufacturers Association (NEMA) initiated the development of the National Transportation Communications for Intelligent Transportation Systems (ITS) protocol in 1992. In January 1996, the United States Department of Transportation established the ITS Standards Program to encourage the widespread use of ITS technologies in the nation's surface transportation systems. The NTCIP was then formed, as a joint standardization project of AASHTO, ITE, and NEMA, with funding from the FHWA.

Since that time, several companies have developed technologies that allow facility managers to better monitor, control and maintain their system assets – including roadway lighting and related electrical systems both above and below ground – as well as their system's energy usage and safety factors. This effort grew to include street-light control, ground fault detection and revenue-grade power metering. It has been published at the ITS Standards NTCIP123 "Electrical Lighting and Management Systems."

Types of ELMS systems

ELMS have been developed and implemented in many sites across the globe. Initial installations focused simply on energy management, essentially whether the lighting fixture was powered or not powered, and whether a schedule could be remotely applied to each individual fixture. Later basic power metering functions were added, both to confirm operation, and to assist in diagnosis of fault conditions.

Three weaknesses of these initial approaches were rapidly observed.

The first was that these systems were proprietary in nature. They required a dedicated PC for a user to read the performance data and apply changes to the system. These proprietary systems often required a lengthy and pricey maintenance contract with the vendor.

Secondly, many of these systems required users to host their facility's data offsite – on the vendor's own Web server, and required a sizable monthly subscription fee.

Lastly, after the terrorist attacks of Sept. 11, 2001, many governmental entities, including the U.S. Department of Homeland Security were very reluctant to host critical infrastructure data at vendors' sites that may have had minimal or even unknown security safeguards. These same entities also require network communications to be entirely resident within the private NTCIP physical communications network.

The NTCIP 1213 subcommittee on ELMS embraced the above three issues as well as many others, and through a rigid systems engineering process, beginning in the autumn of 2003, defined and required both open protocols and roadside/on-site data hosting on private secure networks.

Today, systems offer scheduling and monitoring of lighting, power metering, ground-fault detection and other features such as pole knockdown detection, and arc-fault detection – all in secure, open protocol platforms that allow system designers and implementers to choose "best-of-breed" software and hardware features and components, thus allowing the creation of robust adaptive lighting control systems that meet the exact user needs of each particular installation.

Benefits of ELMS technology

Reduced lighting costs: The primary costs of operating a streetlight include the following general categories: electricity, maintenance and replacement.

Current conventional practices require street and roadway lighting to be controlled by dedicated photocells. As a result, the entire grid is turned on at nightfall and turned off at daybreak. The result is that the entire grid is fully powered and illuminated even at off-peak hours in the middle of the night – when illumination may not be desired or required

Street light maintenance typically involves visual inspection on a routine basis. Typically, employees drive the physical network to visually diagnose anomalies. In many cases, lighting ballasts and related components are replaced only when they fail.

ELMS technology directly attacks deficiencies in all of these important areas. Instead of keeping an entire grid fully illuminated throughout the night, ELMS software allows for customized scheduling. For example, particular lighting segments, or even individual lights can be extinguished in the early morning hours when very little traffic is expected through a system.

ELMS technology also eliminates the need for maintenance personnel to visually inspect the system. Instead, the software immediately identifies problems, while also providing the means to diagnose and correct problems remotely.

Finally, ELMS technology allows for predictive replacement and coordinated replacement schedules, allowing for greatly enhanced asset management

The cost savings of ELMS technology is impressive and has already been realized by the City of Oslo in Norway.

That particular system drew the attention of Robert T. Grow, a Ford Fellow at the American Chamber of Commerce Executives in Washington, DC. Grow, in a March 2008 white paper, released the results of his study on energy efficient streetlights.

Grow reported that, in 2004, San Jose, CA, based Echelon Corp. partnered with Philips Lighting and Konigsberg Analogic AS to install a managed street lighting system in Oslo. It is considered to be the first such large-scale implementation of a control network in Europe.

Oslo, Grow said, has cut total electricity usage by 50 percent with a five-year return on investment. The city has seen improved roadway safety and saved funds by cutting down on maintenance costs.

In addition, Grow reported that the City of Milton Keynes in Great Britain is using monitored street light technology in a trial project involving 400 street lights. Another 10,000 are expected to be added over the next three years.

In Canada, Ville de Quebec installed a system in October 2007 with 200 street lights in its historic district. The trial project will add 1,000 lamps annually over the next decade.

The study contends that the 10 largest metropolitan areas in the U.S. can save energy by implementation of managed streetlight networks engaging "smart" streetlight technology or by using new energy efficient streetlamps such as LED (light emitting diodes) or through a combination of both.

The findings are impressive: The top 10 U.S. urban centers can save $90 million annually in electricity costs while reducing greenhouse gas emissions by 1.2 million metric tons of carbon dioxide.

The study assessed street-lighting costs in the New York City, Los Angeles, Dallas/Fort Worth, Philadelphia, Houston, Miami, Washington, Atlanta, and Detroit metro areas.

Karl A. Burkett, a consultant lighting and electrical engineer who runs his own company, Karl A. Burkett and Associates in Austin, TX, is a major proponent of ELMS.

And, after 30 years with the Texas Department of Transportation, he knows his streetlight technology.

He notes the trend that many government functions, especially in a time of recession, are reducing staff and privatizing operations.

"ELMS provides reliable lighting system operational condition information that may be used as a basis for payments to contractors," Burkett said. "In this scenario, satisfactory operational condition would be defined as maintaining lighting systems operational at or above a certain percentage, say 96 percent All totaled, dimming and curfews (scheduled shut-down times) will potentially save 20 percent or more system-wide in electricity use."

Another industry expert, Don McLean of DMD & Associates Ltd., with nearly 30 years experience in the design of transportation-related lighting systems, traffic signals, and power distribution and control systems also sees clear benefits of the ELMS-type technology (which can be both wireless and power-line based).

"Technology which retrofits into street lights has the potential to save 5 billion kW/h of power each year in North America through dimming street light lamps during non-peak periods. Besides dimming of the luminaires, an asset management feature tied into a Global Positioning System (GPS) assigns coordinates to each street light which allows outages to be located, tracked and reported via wireless systems and the Internet," McLean said, citing costs savings in the area of 35 percent.

Increased safety: Safety issues related to operating street light systems often center on maintenance issues – dangerous electricity leakage as the result of aging of the installed infrastructure as well as downed wires and poles (due to storms or accidents)

If the lights go out – or lighting is interrupted – the situation might go unreported for hours, days, or even weeks.

In the interim, there can be dangerous levels of electrical leakage at the streetlight poles, sidewalk located pull boxes, and at other portions of the installed infrastructure. Darkened areas also invite crimes of property such as vandalism or burglary, increased pedestrian vulnerability, and personal crimes such as assault or worse.

ELMS technology monitors electric power via NTCIP 1213 compliant data loggers over power lines and over wireless networks. The data loggers collect and distribute operational data, from field installed control components – including streetlight controllers, power meters, and ground-fault detectors. Whether power-line based or wireless, these systems have proven to be very reliable.

What the system offers can very well be life-saving, particularly in terms of electricity leakage and its dangers. ELMS software enables users to monitor electrical usage – from streetlight to streetlight and, consequently, for vulnerable areas in between.

Ground-fault detection. It doesn't sound impressive, but the inability to determine does often determine the difference between life and death. Electricity leakage from equipment assets in the public right of way is not an issue that historically has received much public attention.

In the past few years, "live" streetlight poles, pull boxes, and other roadside mounted physical hardware, electrified as the result of failed or damaged components, have claimed the lives of humans and dogs – even a horse – in cities around the United States.

ELMS technology actively targets this significant problem.

Recently, remote street-lighting technology was implemented in a south Florida installation to verify the operation of two lighting circuits designed and tested by an electrical contractor.

The contractor signed off on the installation, verifying its operation and safety.

Upon installation of an ELMS monitoring and control system, the controls immediately found 300 milliamps of current leakage in both circuits – the system (set at a 100ma trigger level) then removed power to both circuits. To put that in layman's terms, residential ground-fault detectors, as found in your bathroom or kitchen, are set to shut down power sources if leakage of just five (5) milliamps is detected. (Remember that as little as five milliamps at 120 volts can stop the human heart.)

The south Florida governmental entity, after receiving the dynamically generated report, dispatched workers and found both a number of bad ballasts and underground wire that had become damaged. As those were replaced, the leakage level returned to a safe level and the staff moved on to examine other areas for dangerous leakage conditions.

An effective ground-fault device was installed that immediately shuts a lighting circuit off if the current is found to be above the 100 milliamp threshold. The device logs the current and generates reports – to see why and how the current surge occurred.

Reduced liability: The fiscal liability that can result to a municipality or any other entity that owns the "live" very dangerous pole or pull box can go into the multi-millions of dollars. There is nothing to visually differentiate a "live" pole from a regular one. The difference is learned far too late in most cases.

Monitoring of electrical leakage and electrical usage in street-lighting systems can pre-emptively detect a dangerous leakage condition – and prevent both a tragedy and accompanying litigation.

A manager – such as a public works manager – can monitor readings from a laptop computer, or a handheld PDA like a Blackberry or iPhone. With such rapid communication, he or she, or the system itself, can turn off the power to specific lights or specific circuits as soon as a dangerous situation is detected.

That virtual instant notification not only makes a dangerous situation safer for first responders, it also means energy efficiency and significant cost reductions for infrastructure managers, system users and maintenance people as well as for the taxpayers, and the public at large – important factors in anyone's bottom line these days.

Federal standards

The rigorous systems engineering process employed by the NTCIP 1213 committee resulted in a completed standard that was approved in 2007. Adherence to this standard not only allows interoperability between the various sub-systems of an integrated intelligent transportation system – allowing creation of many powerful cost saving diagnostic applications but also allows projects to apply for significant federal funding contributions

Many funding opportunities are available today, typically through legislation such as the U.S. Transportation Bill SAFETEA-LU's "Safe Routes to School" program.

Features under development

With America's continued reliance on foreign sources of energy, and the continued instability of world energy markets, energy costs are expected to continue to rise at an accelerating rate.

The 60 million street and roadway lights in the United States consume approximately 15 percent of the nation's total energy usage. Intelligent control of these lighting loads can greatly impact this power consumption, and can minimize the production of green-house gases

With the ELMS digital, open protocol technology, many new features are quickly appearing, such as:

Dynamic truck routing – where a maintenance crew continually receives an dynamically updated work schedule on their PDA or phone based on real-time maintenance issues encountered in the field combined with the truck's physical location and tools, components and staff available on the particular truck in that specific location.

Finance departments can, in real-time, view power usage, and can load shed during peak power periods, lowering their overall energy bills

Cities, counties and states can simply power down various parts of their infrastructure for reasons of weather or national security

Maintenance managers can contrast the real-life performance and longevity characteristics of various parts of their electrical infrastructure – in order to truly know the aggregated performance and life characteristics of ballast, starter and luminaire assemblies

And as dynamic lighting takes hold in the United States, lighting levels can be dynamically adjusted, as when the increased reflectivity of a rain slick road requires a lower lighting level – for increased safety.

This real-time dynamic management of ALL the system assets can yield tremendous productivity dividends – and can free up these workers and assets for other critical tasks required in the world of roadway management

Key U.S. suppliers

Holophane: Holophane's ROAM® provides monitoring and control of indoor and outdoor lighting infrastructures utilizing a combination of intelligent photocontrols, machine-to-machine communications, wireless communications, and network management services. Holophane is one of the oldest manufacturers of lighting-related products in the world; founded in 1898. They are a US manufacturer (based in Newark, OH) of lighting fixtures for commercial, industrial, outdoor, and emergency applications

Tyco Electronics: Tyco Lumawise systems are manufactured by Tyco Electronics, a US$13.5 billion global provider of engineered electronic components for thousands of consumer and industrial products; network solutions and systems for telecommunications and energy markets; and wireless systems for critical communications, radar and defense applications.

Strategic Telemetry Inc.: Strategic Telemetry's SMART Management® System - STI is focused on intelligent lighting solutions. STI offers a full range of adaptive lighting controls that enable state departments of transportation, municipalities and other public and private organizations to implement integrated NTCIP compliant systems for remotely monitoring and controlling street and roadway lights. STI utilizes Strategic Monitoring and Remote Traffic SMART Management® System technology, solutions and components to help customers lower costs, reduce potential liability, improve electrical safety, and conform to federal standards.

Conclusions

ELMS adaptive lighting technologies are rapidly entering the American market. These technologies reduce energy consumption, reduce the generation of greenhouse gases, improve the efficiency of maintenance operations, and uncover dangerous electrical leakage conditions, critical to saving lives.

ELMS usage is in its infancy. However, the obvious benefits of ELMS, particularly in the face of escalating energy costs, insures that ELMS' role in illuminating America – and the world's – highway systems will expand rapidly.

References:

NTCIP 1213 <<JIM – I need more on this>>

Karl A. Burkett, "Is ELMS the Answer?" Copyright December 2004, Karl A. Burkett, P.E. www.karlburkett.com

Robert T. Grow, ACCE Ford Fellow/Greater Washington Board of Trade, "Energy Efficient Streetlights – Potentials for Reducing Greater Washington's Carbon Footprint."

About the author:

Jim Frazer has more than 20 years of experience in distributed control systems for home, commercial and industrial applications. He is an active member of the International Municipal Signal Association, and the Illuminating Engineering Society of North America's Roadway Lighting and Energy Management committees. He continues to play a significant role in the evolution and adoption of the US Intelligent Transportation Systems NTCIP 1213 standard for Electrical Lighting and Management Systems, more popularly known as "ELMS".

Jim will be expanding upon the concepts presented in this document during a July 22nd technical session at 113th Annual IMSA International conference. At this event, Jim will review the features and benefits resulting from various implementations of the new US Federal Highway Administration Intelligent Transportation Systems ITS NTCIP 1213 Standard for "Electrical Lighting and Management Systems". Attendees will learn how to enhance street and roadway lighting maintenance plans, monitor and control dangerous ground fault / electrical leakage conditions and monitor and control power usage by circuit and by fixture. The presentation will examine integration issues with other ITS sub-systems in order to create expanded features that save additional critical resources including energy and lives!

For more information on Jim and his organization, Strategic Telemetry Inc. – please visit www.strategictelemetry.net