

Initiatives in Adaptive Lighting:

Applications of the ITS Electrical Lighting and Management Standard

In our initial article, published in Fall 2008, we introduced the US Federal Highway Administration's ITS initiative for the nation's Electrical Infrastructure; subsequent articles focused on the important areas of energy management of roadway lighting, and the innovative applications created when merging attributes from various ITS subsystems.

In this article we'll look at the evolution of ITS Electrical Lighting and Management Systems technology, better known as "ELMS" – and some of the creative applications being deployed today.

Review of NTCIP & Related Standards

One mandate of the US DOT's Federal Highway Administration's ITS effort is standard software interfaces – or profiles – for each of the subsystems on the US ITS roadway network. This requirement resulted from integration difficulties in the past, thus this "plug and play" scenario was implemented.

First a "language" needed to be created – this effort became known as The *National Transportation Communications for ITS Protocol* – or NTCIP for short.

Let's briefly review the ITS NTCIP hierarchy:

NTCIP standards are based on a layered approach very similar to those used by the International Organization for Standardization (ISO) and the Internet community. The following are descriptions of 4 of the 7 levels of the NTCIP stack:

1. **Information** - Information Standards define the data to be exchanged and the format of that data.
2. **Application** - Application Standards (also known as Profiles) define the rules and procedures for exchanging information data. The rules may include definitions of proper grammar and syntax of a single statement as well as the sequence of allowed statements. This is similar to combining words and phrases to form a sentence or a complete thought and defining the rules for greeting each other and exchanging information. These standards are equivalent to the Session, Presentation and Application Layers of the ISO seven-layer stack.
3. **Transport** - Transport Standards define the rules and procedures for exchanging the Application data between point 'A' and point 'X' on a network. This includes any necessary

routing, message disassembly/reassembly and network management functions. This is similar to the rules and procedures used by the telephone company to connect two remotely located phones.

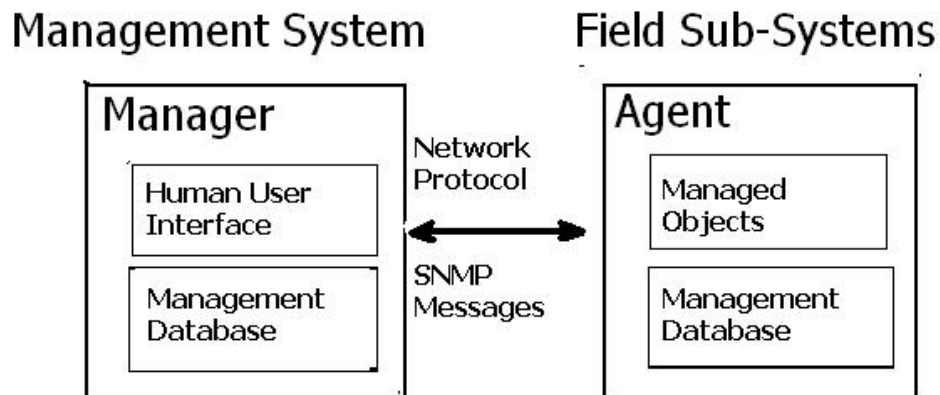
4. **Subnetwork** - Subnetwork Standards define the rules and procedures for exchanging data between two 'adjacent' devices over some communications media. This is equivalent to the rules used by the telephone company to exchange data over a cellular link versus the rules used to exchange data over a twisted pair copper wire.

NTCIP Requires SNMP

Since its creation in 1988 to manage elements in the growing Internet and other attached networks, Simple Network Management Protocol (SNMP) has achieved widespread acceptance.

SNMP Based on Manager/Agent Model

SNMP is based on the manager/agent model consisting of a manager, an agent, a database of management information, managed objects and the network protocol. The manager provides the interface between the human network manager and the management system. The agent provides the interface between the manager and the physical device(s) being managed. Addressing conventions required to access a particular data point is accomplished by means of an **object identifier** or **OID**. An OID is a numeric tag or object identifier used to distinguish each unique variable in the Management Information Base (MIB) and in the SNMP messages.



SNMP uses five basic messages (GET, GET-NEXT, GET-RESPONSE, SET, and TRAP) to communicate between the SNMP manager and the SNMP agent. The GET and GET-NEXT messages allow the manager to request information for a specific variable. The agent, upon receiving a GET or GET-NEXT message, will issue a GET-RESPONSE message to the **SNMP manager** with either the information requested or an error indication as to why the request

cannot be processed. A SET message allows the SNMP manager to request a change be made to the value of a specific variable in the case of an alarm remote that will operate a relay.

After the SNMP protocol was selected, the applications were proposed, debated and approved... resulting in a broad range of application or “profile” standards. A few are listed in the table below:

| Profile | Description |
|---------|--|
| 1203 | NTCIP Object Definitions for Dynamic Message Signs (DMS) |
| 1204 | NTCIP Environmental Sensor Station Interface Standard |
| 1205 | NTCIP Objects for CCTV Camera Control |
| 1206 | NTCIP Object Definitions for Data Collection |
| 1207 | NTCIP Object Definitions for Ramp Meter Control (RMC) |
| 1208 | NTCIP Object Definitions for Video Switches |
| 1209 | NTCIP Object Definitions for Transportation Sensor Systems |
| 1210 | NTCIP Objects for Signal System Masters |
| 1211 | NTCIP Objects for SCP |
| 1212 | NTCIP Objects for Network Camera Operation |
| 1213 | NTCIP Objects for Electrical Lighting & Management Systems |

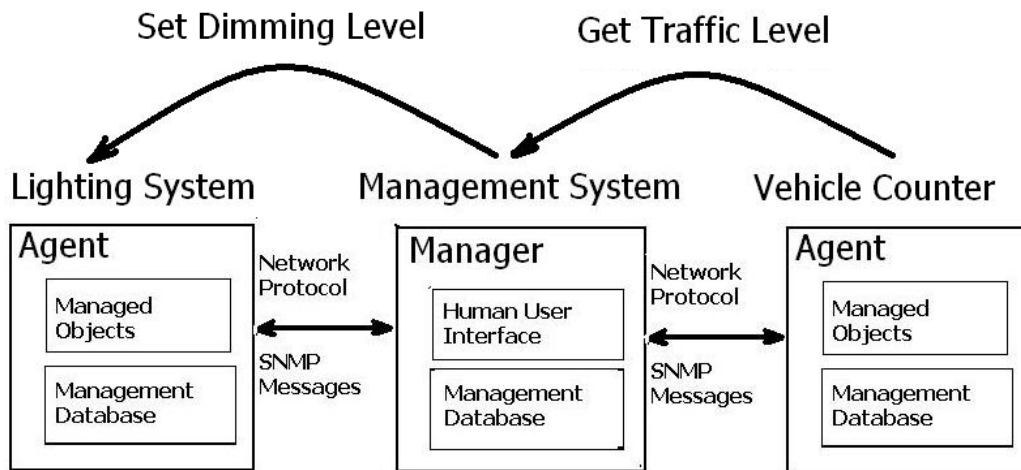
Real World Applications: Dimming Lighting Based on Traffic Volumes: NTCIP 1206 & NTCIP 1213 Object Definitions and Their Integration

The standard NTCIP 1206 - Object Definitions for Data Collection and Monitoring (DCM) Devices, provides the vocabulary - commands, responses and information - necessary for traffic management and operations personnel to control, manage, and monitor data collection and monitoring devices such as loop detectors, radar detectors and other sensors. This standard contains object definitions to support the functionality of these devices as used for transportation and traffic monitoring applications. Object definitions included in NTCIP 1206 include vehicular traffic counts, by day, by hour, and even by type of vehicle.

The standard NTCIP 1213- NTCIP Object Definitions for Electrical Lighting and Management Systems, is more commonly known as “ELMS”. ELMS equipment is a telemetry-based remote monitoring and control system for highway lighting. ELMS is an effective tool for lowering costs, improving maintenance management, reducing liability, implementing lighting curfews, and increasing safety. There are many different providers of this equipment, each with their own set of features and interfaces. This standardization effort creates a common set of features and

functionality, and defines the point of interoperability. Object definitions included in NTCIP 1213 include individual streetlight dim levels and performance characteristics.

Once you have deployed systems compliant with NTCIP1206 and NTCIP1213, commonly available SNMP network management software packages such as the Hewlett Packards' popular OpenView software suite allow you to quickly configure the system logic to "GET" TRAFFIC LEVEL; upon finding a traffic volume level below that required for full lighting, you can generate a "SET" DIM LEVEL to 50%



Similarly by examining the table of NTCIP objects and applications above, it becomes easy to imagine, and to integrate applications with much greater subsystem object and application dependencies.

Examples of such applications, that rely on data inputs from other systems can include:

1. Variable vehicular and pedestrian light levels based on ambient light, by using analog, 0 to 10 volt output photocells rather than on/off digital versions.
2. Dimming of fixture based on hours of run-time – Fixtures can be dimmed significantly at time of installation, then, as fixtures age and drop in light output, dimming can be diminished.
3. Fog, rain, smoke, and snow each have unique reflectivity characteristics that can cause a road to be over lit. Integration with weather sensors can increase safety and save energy.
4. Department of Homeland Security (DHS) event notification and messaging. Sequencing of roadway lighting, strobe flashing, or unique colors can indicate a safe evacuation path.

5. Vehicle speed can be one input used to determine the minimum distance of lighted roadway in advance of the vehicle path

Other multi subsystem applications depend on data being delivered from the ELMS subsystem to another ITS subsystem. Applications that demonstrate data flow out of an ELMS subsystem include power outage information communicated to Dynamic Message Signs, and poles that have been “knocked down”, immediately generating messages to emergency management service personnel.

ELMS Components

Earlier, we discussed interoperability and the 7 OSI levels of the ITS NTCIP architecture. ITS systems rely on this interoperability to allow system designers to choose the best components for the project – and to be sure that they work together smoothly and efficiently. ITS systems also typically rely on a hardwired physically isolated network – for reliability.

The components that comprise an ITS NTCIP 1213 compliant “ELMS” subsystem follow the same philosophy. They also communicate on a private hardwired network, and adhere to the 7 layers of the OSI model. Popular components that can be integrated into an “ELMS” system include roadway lights, power meters and ground fault sensors.

One such vendor of ELMS components is XUS Corporation, a leading manufacturer of LED roadway lighting fixtures. Bob Gray, President of XUS, agrees, “Support of the multitude of data points within the U.S. Federal Highway Administration’s ITS standards allows XUS to offer control, monitoring and diagnostics previously unimaginable to the street and roadway lighting marketplace.”

Norman Krebs, President of ROMlight International (USA), Inc., manufacturer of communicating dimmable electronic ballasts adds “Our StreetROM ballasts connect directly to ELMS compliant data loggers without the need for additional, expensive, and bulky external hardware. The integration of ROMlight and ELMS technologies provides this unique next generation built-in two way communication feature in HID ballasts. “

Dean Hamill of HID Digital, a manufacturer of communicating dimmable electronic ballasts, states “HID Digital provides a complete range of metal halide and a wide range for HPS. From 50 watts to 575 watts they all replace twice the existing wattage in core and coil being used today. They all offer support of “ELMS” technology.”

Among the most popular and robust protocols for ELMS component to component communication is Echelon Corporation’s LonWorks™ technology. As Steve Nguyen, Echelon's

Director of Marketing states “Smart streetlight systems using the LonWorks platform communicate over the existing power mains. Doing so is not only the most economical and reliable means of networking streetlights, it's a means of ensuring that a city can install new lamp technologies as they reach the market.”

Summary

In this article, we examined the architecture of the ITS network, discussed the NTCIP protocol and described a number of interesting energy management applications being deployed today.

In addition to direct energy savings of 50% or more, CO2 emissions can be greatly minimized. Other benefits include:

- Increased safety due to increased “up-time” of each lighting fixture
- Quick recognition of dangerous ground fault issues
- Reduced liability due to fast EMS response to pole knockdowns and other critical issues
- Much more efficient scheduling and deployment of trucks, tools, personnel and replacement components.
- Open protocol of both the ITS network, and the ELMS subsystem guarantees a system that’s “future-proofed”. New advanced hardware and software components can be quickly implemented into existing installations.
- Revenue-grade power metering allows you to only pay for the power you use, and to quickly diagnose power system irregularities.

Savings & Safety

All of the benefits above can be grouped into categories of savings and safety. Time, resources, labor and energy are all saved.

Safety is enhanced by putting the correct amount of light on the road at all times, and by immediate notification when the infrastructure itself has created a dangerous condition.

That is why the ELMS community sums up their philosophy with the statement:

Saving Time, Energy & Lives, with ELMS Technology!

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.

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 U.S. Intelligent Transportation Systems NTCIP 1213 standard for Electrical Lighting and Management Systems, more popularly known as "ELMS". Jim can be reached at 954 281 8927 or at jfrazer@strategictelemetry.net