Intelligent Transportation Systems and The Smart Grid

By Jim Frazer

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, “ELMS” in both the intelligent transportation and smart grid markets.

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What are Intelligent Transportation Systems?
The term intelligent transportation system (ITS) describes the process of adding control, monitoring and communications technology to transportation infrastructure and vehicles to improve safety, reduce energy consumption, and to reduce vehicle wear, and transportation time.

Development and application of ITS technology is also driven by the need for homeland security, and many of the proposed ITS systems also involve surveillance of the roadways. Additionally, through coordination with the U.S. Department of Energy, many ITS applications are also supported, enhanced and on occasion, driven by the needs of the Smart Grid electrical distribution technologies.

The Intent of ITS NTCIP Standards
In 1996, the National Electrical Manufacturers Association (NEMA) teamed with the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO) under a RITA ITS JPO contract to obtain more direct user input in the standards development process. The NTCIP Steering Group has been reorganized as the Joint Committee on the NTCIP, an official Steering Committee of the FHWA-funded project.

The NTCIP is a family of standards that provides both the rules for communicating (called protocols), and the vocabulary (called objects) necessary to allow electronic traffic control equipment from different manufacturers to operate with each other as a system. The NTCIP is the first set of standards for the transportation industry that allows traffic control systems to be built using a “mix and match” approach, with equipment from different manufacturers. Therefore, NTCIP standards reduce the need for reliance on specific equipment vendors and customized one-of-a-kind software. To assure both manufacturer and user community support, NTCIP is a joint product of the National Electronics Manufacturers Association (NEMA), the American Association of State Highway and Transportation Officials (AASHTO), and the Institute of Transportation Engineers (ITE). The NTCIP originated as the National Transportation Communications for Intelligent Transportation System (ITS) Protocol (NTCIP).

The purpose of the ITS work by NEMA, AASHTO and the ITE was to create interoperable standards for subsystems on the interstate highway network. These standards became known as National Transportation Control ITS Protocol (NTCIP) standards.

The Purpose of NTCIP Standards
In years past, transportation organizations developed, installed and integrated systems with unique data definitions and proprietary (non-open) communications protocols. Field devices and systems from one manufacturer or developer could not interoperate with those of other manufacturers or developers. Thus, expansion of the system after installation could generally only be accomplished using equipment of the same type and brand as in the initial deployment, unless very significant investments were made in software and hardware protocol translators. In many cases, the underlying...
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ing language(s) are proprietary to the extent that a translation simply cannot be made, due to licensing, intellectual property and even simple documentation issues.

With proprietary protocols there is virtually no opportunity for realistic competitive bidding as the system expands, due to the lack of interchangeability. Nor is there any opportunity for realistic competitive bidding to add additional types of field devices to the system, due to the lack of interoperability, or as it is more typically termed, “interoperability”.

NTCIP is a collection of open standards, defining common communications protocols and data definitions. The NTCIP standards describe and define common data definitions and open protocols. The proper use of NTCIP open standards in an ITS deployment allows future systems expansions to benefit from true competitive bidding. In addition, it allows other types of field devices to be added. Overall, NTCIP is an entire family of standards designed to meet the communications needs of various fixed-asset roadside devices and traffic management centers.

Interoperability and Interchangeability reduce the total life system costs (procurement, operations and maintenance). Interoperability and interchangeability are two key goals of the NTCIP open standards effort. The terms interoperability and interchangeability generally reflect the ability to use multiple brands of a device on the same communications channel, along with the ability to swap them out. For example, the ability to put any brand of NTCIP-conformant street light controller in the same system at the same time reflects interchangeability for that device type. It is for this reason that the NTCIP family of protocols is being widely embraced and specified in many new system deployments.

Benefits of NTCIP
NTCIP standards offer tremendous flexibility and a wide range of choices for agencies operating transportation management systems. It removes significant barriers to interagency coordination and allows equipment of different types and different manufacturers to be mixed on the same communications line.

Avoid Early Obsolescence: While retrofitting legacy equipment and systems with NTCIP support is not practical in most situations, most manufacturers offer NTCIP support in their current and future products. It is possible to migrate a system gradually, since it is possible to operate a mixture of NTCIP and non-NTCIP devices in the same system, though not on the same communications line.

Providing “Plug and Play” Vendor Choice: Since a computer system that supports NTCIP can communicate with any product from other manufacturers that are NTCIP-conformant, the number of manufacturers and systems, field devices, or software that can be considered for purchase increases tremendously. NTCIP does make it easier for an agency to gradually change its software, controllers and other field devices from one manufacturer to supporting multiple manufacturers for the entire system.

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Enable Interagency Coordination: NTCIP allows agencies to exchange information and (with authorization) basic commands that enable any agency to monitor conditions in other agencies’ systems, and to implement coordinated responses to incidents and other changes in field conditions when needed. Such data exchange and coordinated response can be implemented either manually or automatically. One agency can monitor and issue basic commands, if authorized, to field devices operated by another agency, even though those devices may be from a different manufacturer than those used by the monitoring agency.

Use One Communications Network for All Purposes: NTCIP allows a management system to communicate with a mixture of device types on the same communications channel. For example, with the addition of appropriate application software in the system computer, a dynamic message sign could be installed near a signalized intersection, and the computer could communicate with the sign controller using the communications line or channel already in place for the traffic signal controller.

The ITS Standard for Electrical Lighting and Management Systems
In 2003, a rigorous system engineering process to develop user needs and features required in ITS electrical lighting and management systems was unveiled. This effort grew to include streetlight control, ground fault detection and revenue grade power metering. It has been published as the ITS Standard NTCIP 1213 “Electrical Lighting and Management Systems” or ELMS for short. ELMS compliant systems are a telemetry-based remote monitoring and control system. It is an effective tool for lowering costs, improving maintenance management, reducing liability, implementing lighting curfews, and increasing safety.

Intelligent Transportation Systems & The Smart Grid

What is a Smart Grid?
A Smart Grid delivers electricity from suppliers to users using bi-directional digital technology to control and monitor devices located at homes, commercial and industrial sites, as well as on the electrical distribution system itself. The goals of a Smart Grid are to save energy, reduce cost and increase reliability and transparency. Such a modernized electricity network is being promoted as a way of addressing energy independence, global warming and emergency resilience issues.

A smart grid includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It also incorporates the capability of integrating alternative sources of electricity such as solar and wind.

Smart Grid Interoperability Standards Project
Under the Energy Independence and Security Act (EISA) of 2007, the National Institute of Standards and Technology (NIST) has “primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems…”

As specified in the American Recovery and Reinvestment Act (ARRA), NIST received $10 million through the Department of Energy (DOE). This resource commitment has created a substantial effort to develop a comprehensive interoperability framework for a nationwide Smart Grid for the U.S. electric power distribution system.

The Smart Grid is a critical key to national efforts to further energy independence and curb greenhouse gas emissions. With industry, government, and consumer stakeholders, NIST is expediting identification and development of standards critical to achieving a reliable and robust Smart Grid.

Interoperability (the ability of diverse systems and their components to work together) is vitally important to the performance of the Smart Grid at every level. It enables integration, effective cooperation, and two-way communication among the many interconnected elements of the electric power grid.

Effective interoperability is built on a unifying framework of interfaces, protocols, and the other consensus standards. These standards facilitate useful interactions so that, for example, “smart” appliances and meters will tell consumers how much power they are using and at what cost, thus, providing them with more control over their power consumption and energy bills. Widely adopted standards will also help utilities to mix and manage varying supplies of solar, wind, and other renewable energy sources and better respond to changing demand. Support of the ITS NTCIP 1213 standard allows inclusion of ITS projects into the Smart Grid domain.

The task for this U.S. DOE / NIST Smart Grid effort is very similar to the process that the US Department of Transportation implemented for developing standards for the Intelligent Transportation domain. Like standards in the ITS world, Smart Grid interoperability and cyber security standards reflect industry consensus, with active participation, and where required, leadership and coordination by government.

The Convergence of ITS ELMS & The Smart Grid
Accelerating development of the Smart Grid ranks among the Obama Administration’s top priorities. Funding through the American Recovery and Reinvestment Act provides a tremendous opportunity to “jump start” implementation of the Smart Grid.

On February 3, 2010, NIST issued a “roadmap” for Smart Grid interoperability standards, which that is a document which resulted from the compilation and distillation of hundreds of stakeholder comments. This roadmap, available online at www.nist.gov/smartgrid references ITS NTCIP 1213 “ELMS” as a supported application standard, making ELMS projects eligible for Federal Smart Grid funding. In addition to the currently developed standard, an evolution of the NTCIP 1213 standard is underway, which will include support for electric vehicle charging stations, and support of wind and photovoltaic power generators.

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An Integrated ELMS Smart Grid in Minneapolis

Background

Lighting, signage and traffic signals in Minneapolis, as in many other locales, are the most numerable fixed assets of roadway infrastructures. Maintaining this equipment has long been a costly and arduous business.

Since these assets are exposed to the environmental extremes of Minnesota, traffic accidents, and occasional vandalism, they need to be strong and robust. Additionally, ongoing deterioration of this field-mounted equipment leads to increased maintenance costs, energy usage and system failures that can cause accidents or even deaths.

Traditionally, repairing inoperable roadway lighting components required visual confirmation of the problem. Typically, a passing motorist may report that a light or series of lights are out, or a pedestrian may report electrical leakages.

When a report of an issue occurs, a maintenance crew from the organization is normally dispatched for an inspection, which in turn, accumulates overhead, personnel, and vehicle maintenance costs. Sometimes, a second or third trip to the site may be necessary to complete repairs, incurring even more expenses.

Obvious costs related to these issues are oil changes, tire replacement, and the increasing cost of fuel. Less obvious, but equally notable are the environmental impacts of greenhouse gas emissions from the trucks, and the costs and environmental impacts associated with the disposal of waste oil, tires, and the service vehicle itself. Minneapolis faced many of these issues with their existing infrastructure.

The Solution

In light of these issues, the City of Minneapolis subsequently chose to take a proactive step forward, accomplished through the installation of an ITS ELMS Smart Grid covering twenty-six city blocks throughout the downtown business and entertainment districts.

Among its many features, this Smart Grid system includes individual streetlight control and monitoring, and scheduling of each light. Revenue grade metering at each roadside electrical service cabinet is offered along with circuit based ground fault detection. Reporting functions automatically alert the appropriate personnel of system anomalies, including pole knockdowns, light outages and dangerous electrical leakage conditions.

The infrastructure data is conveyed to and from data logger computers, which reside in each service cabinet. Each data logger communicates back to the Public...
Works central office over a robust fiber ITS compliant backbone. At the Public Works Traffic Management Center (TMC), Strategic Telemetry’s SmartLights™ software interprets and displays the information collected by data loggers. Additionally, SmartLights™ sets the field operational parameters, including lighting dim levels, lighting schedules and alarm levels for the ground fault detectors.

The result is that hundreds of streetlights, and dozens of roadside electrical service cabinets can be remotely controlled and monitored, in turn, saving energy, conserving the city’s maintenance assets, and increasing safety to the vehicle operator and pedestrian alike. A significant added benefit is that payback of systems such as these can be in as little as five years.

Concluding Points

1. The standards and technologies of the Intelligent Transportation Systems effort and those of the Smart Grid are converging.

2. Leveraging the complementing benefits and strengths of ITS & the Smart Grid can lead to a range of broad variety of infrastructure enhancements that save time, resources and lives.

3. ELMS Smart Grid systems are very cost effective, often yielding a payback in the range of five years.

References:
NIST Framework and Roadmap for Smart Grid Interoperability V1.0  
www.nist.gov/smartgrid


ITS NTCIP 1213 Electrical Lighting and Management Systems, Published by The Joint AASHTO / ITE /NEMA Committee on the NTCIP

Funding
ELMS and ITS have been funded through the national surface-transportation legislation known as SAFETEA-LU. The reauthorizing bill drafted by Congressman James Oberstar (D-Minn.) includes significant support for ITS applications in general, and more specifically for NTCIP 1213 compliant energy and safety applications.