
NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL

CASE STUDY REPORT

NTCIP 9007 v01.05

City of Mesa, Arizona Signal System Upgrade

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PREFACE

When early adopters began using the NTCIP in their deployment activities, there was limited guidance available. Since then, *The NTCIP Guide* (NTCIP 9001) has been developed to help users understand, specify, and deploy the family of standards. NTCIP 9001 version 03 was completed in 2002 and is now available.

Early NTCIP deployments and the initial NTCIP case studies identified issues due to content ambiguities and shortfalls in the first version of several standards. Subsequent amendments addressed many of these issues.

Case study reports revealed that functional requirements within user specifications could be improved. As a result, a systems engineering approach to standards development has been adopted to help users better specify NTCIP-based systems. New versions of ITS standards will add sections on concepts of operation, functional requirements, traceability to the data dictionary, and dialogs and sequences.

Early adopters also revealed that testing was an issue in many of their deployments. An NTCIP working group on testing and conformity assessment was created in 2002 to further assess and define testing issues.

The case studies also revealed a general need for continued outreach, education, and training. These needs are being addressed through a variety of ongoing standards development organization activities.

These NTCIP case studies have proved valuable to the ITS community and have facilitated the continued improvement of the standards. As a result of lessons learned from the case studies, and improvements in the standards development process, future deployments are expected to face fewer challenges.

1. PURPOSE OF THE CASE STUDY

1-1 INTRODUCTION

Field deployment of NTCIP-conforming equipment has begun. State and local Departments of Transportation and their consultants are aware of the interoperability and interchangeability features promised by the NTCIP, and are including references to the NTCIP in their procurement documents. For all but a few, this is their first experience with the NTCIP.

The purpose of this project, sponsored by AASHTO, FHWA, ITE, and NEMA, is to:

- a. Prepare a second series of case studies that describe the lessons-learned by Vendors, agencies, and consultants during another five of the early projects that required NTCIP compliance, and
- b. Update the existing three Case Study projects.

The objective is to compile an unbiased investigation that incorporates the perspectives from different implementation positions.

Two Environmental Sensor Systems (ESS)¹ projects, one Center-to-Center Project using NTCIP 2304 (DATEX-ASN), and two traffic signal control projects were selected for Phase 2 of the study. The two Variable Message Sign (VMS) projects and the one signal control project investigated during Phase 1 are to be revisited to update the status of these projects. Additional projects may be investigated in FY 2003.

The material for these eight case studies (5 new ones and 3 updates) were drawn from interviews with individuals who were directly involved in the NTCIP implementation and from project-related documents such as specifications, test plans, and procurement documents. An attempt was made to interview at least three individuals that performed different roles in each project, such as Agency champion, procurement specification writer, Agency field technician, and Vendor representative. The interviews, conducted by individuals familiar with the NTCIP, were structured around an updated survey prepared for these case study investigations. Whenever possible, relevant project documents for each project are included in that case study report.

This document focuses on the implementation of devices using the NTCIP. It does not attempt to explain the details of the NTCIP. Additional information on the NTCIP, including specific NTCIP standards, is available on the NTCIP Website (www.ntcip.org)².

2. THE CASE STUDY

The Agency has operated a variety of traffic signal systems since the early 70s, and this is the fourth round of system upgrades in the city. Previous upgrades have included:

- Prior to 1983, there were a variety of traffic control devices and unmonitored coordination systems in use throughout the city.
- An RFP was issued in 1981 and work commenced in 1983 on a UTCS (Computran ATCS), cable TV communication system that included Winkomatic RCU field units.

1 Environmental Sensor Stations are considered a device subgroup addressed within the NTCIP Standard NTCIP 1204. The term ESS is used to address road weather information systems. ESS are commonly referred to as Road Weather Information Systems (RWIS).

2 The White Paper "Understanding the NTCIP Class Profiles from an End User's Perspective," prepared by the NTCIP Profiles Working Group is an excellent example.

- An RFP was issued in 1987 and work commenced in 1988 on a distributed (Sonex “Escort”), 2-wire teleco 1200 bps half-duplex system that included ZDC field units.

In 1996, the City of Mesa, AZ (Agency) initiated a Request for Proposal (RFP) to upgrade their existing SONEX system, which included a rudimentary requirement for NTCIP, i.e., “Support NTCIP for communication to TS-2 controllers”³. However, the proposed cost was so much higher than estimated, that the Agency withdrew the RFP. In 1997, the Agency again issued an RFP, this time requesting to replace the entire signal system including the central system and the signal controllers. A phased approach was to be used running temporary parallel central systems. One system continued to manage the older SONEX signal controllers and the other managed the new signal controller as they were replaced and came on-line. The NTCIP was specified as the communications protocol of choice for the new components. The central system (termed Mesa Advanced Traffic Management System or Mesa ATMS) was also required to control additional field devices and provide an interface to the SYNCHRO software.

The project schedule is summarized in Table 1. The project was implemented in phases.

- Phase 1: Operational Test – The implementation of the NTCIP and the new signal controllers was to be demonstrated by the Vendor and System Integrator.
- Phase 2: Implementation – After successful demonstration, the conversion from the old system to 82 new signal controllers and the new central system using the NTCIP as the communications protocol took place.
- Phase 3: Final Acceptance – The new system was tested and accepted.
- Phase 4: Enhancements – The Agency determined that it wanted to add new functionalities such as a SYNCHRO interface and capability to control arterial variable message signs to the central system.

Traffic signal controllers at more than 313 signalized intersections will be replaced in a staged effort over multiple years. This project required the replacement of 82 of those intersection controllers. With the new system, local intersection control will be provided through timing plans, resident at the traffic signal controller, that are selected primarily from time-of-day schedules. The existing communications media consists of different types of communications media including half-duplex 1200-bps leased lines, which were to be maintained together with the 8 controllers per communications channel. However, during the course of project, it was determined that this setup could not be maintained while simultaneously utilizing NTCIP. The Agency determined that the 8 drops per communications channel was more important and increased the communications throughput / speed to 9600 baud per second and the communications were modified from half-duplex to full-duplex. Additionally, the Agency is using additional forms of communications such as point-to-multipoint protocol over wireless spread spectrum communications for certain signal controllers. The Agency also uses microwave for communications with CCTV cameras. A point-to-point protocol is used for dial-up connections (for other ITS devices such as arterial VMS)⁴.

The existing and new devices are described in Table A-1⁵. While the Mesa ATMS software is designed to allow control of CCTV cameras, ramp meter controllers, and variable message signs (VMS), the Agency did not own or operate these types of devices at the time this report was written.

³ See page B-12.

⁴ Author’s Note: Wireless communications poses a problem in terms of data security. Currently, the NTCIP standards do not address this issue, but it needs to be addressed when designing a system. The problem is that unencrypted data can be scanned and decoded allowing hackers to gain access to a device. This problem would not be so critical, if proprietary protocols are used. However, if using NTCIP 2101 (PMPP) over a wireless link, the data transmissions are not encrypted. A user should be aware of this problem.

⁵ See Annex A of this report.

This case study focuses on two NTCIP-compliant components of that project. The Vendor and System Integrator for this study were Econolite Control Products, Inc. and The Gardner Transportation Systems Business Unit of Siemens Energy & Automation, Inc. respectively. The Vendor acted as the prime contractor, with the System Integrator as subcontractor to the Vendor.

The objectives of the Agency in implementing this project were:

- To implement an advance traffic management system that operates essentially unattended.
- To monitor and select timing plans for all traffic signals within the system.
- To replace the mainframe-based central system with a modern PC-based system to facilitate traffic control operations.
- To optimize traffic signal timings and reduce driver delay, fuel consumption, and air pollution.
- To minimize the city's maintenance and operating costs.

Table 1: Project Timeline

Agency	Vendor	NTCIP Standards Status	Date
		NTCIP Standards approved (TS 3.2, TS 3.3)	5/96
		NTCIP Standards approved (TS 3.4, TS 3.5)	11/96
		NTCIP Standards published (TS 3.1, TS 3.2, TS 3.3, TS 3.4, TS 3.5)	1/97
		Modifications to TS 3.2, TS 3.3, and TS 3.4 published as Recommended Technical Revisions	5/97
RFP for current project published			3/ 98
	Vendor/System Integrator response to RFP		4/98
Contract Award	Contract Awarded		9/98
		Additional amendments recommended and incorporated with previous Technical Revisions (i.e., OER, time differential, dynObj Table)	11/98
First Intersection online			7/01
Final Acceptance Testing (basically completed)			4/02
Enhancements			Not yet completed

3. PROJECT PROCUREMENT

3-1 PRE-QUALIFICATION

No pre-qualification was required for the City of Mesa's Signal System Upgrade project.

3-2 ADVERTISEMENT / REQUEST FOR PROPOSAL (RFP)

The city's RFP was published in March 1998 and submittals were due a month later. Only one Vendor responded to the RFP⁶ for the traffic signal controller upgrade project. The Vendor selected for this project also had to meet the requirements and was required to use the same data elements supported in the Phoenix ATMS.

3-3 SELECTION & AWARD

The only Vendor to respond to the RFP for the traffic signal controllers was selected based on fulfilling the requirements established in the RFP. After a successful negotiation period, the contract was signed in September 1998. The System Integrator was proposed as subcontractor to the Vendor. Subsequently, a contractual relationship between the Vendor and the System Integrator⁷ was established.

4. SPECIFICATIONS

The specification used for this project was a shorter version of the first (unsuccessful) RFP, which in turn was based on several RFPs from other agencies. The Agency staff had a pretty good understanding of possible, economical, and feasible functionalities and prepared their (first) RFP based on their desires and needs. While the first RFP did include a requirement to support NTCIP, it did not define particular requirements. The Agency staff developed the specifications without outside assistance.

During the development of the second RFP, the Agency learned about the NTCIP and made the decision to specify it. The reason for including NTCIP in the specification was based upon the Agency's goal to become independent of proprietary protocols and to allow future competitive bids without being bound to a particular Vendor. However, at that time (1998), NTCIP was still considered a "moving target" and few experiences were available. Because of this and the lack of NTCIP experience within the Agency, only rudimentary specifications concerning the NTCIP were included in the RFP⁸, which basically required the Vendor (and the System Integrator) to determine the NTCIP requirements.

The Agency considers the RFP used for this project satisfactory, and the process used to develop the specifications was generally effective. However, the Agency anticipates updating its specifications for future purchases to be more specific both in terms of Conformance Groups and Optional object definitions. The Agency also recommends that any Agency new to using NTCIP should start a review of the NCTIP Guide⁹, which explains issues associated with bandwidth limitations, status information, etc.

⁶ See Annex B.

⁷ This setup is a direct 'lesson learned' from the City of Phoenix project in which the Vendor and the System Integrator had separate contract directly with the City (see NTCIP 9004 and NTCIP 9004-Amendment 1).

⁸ See Annex B, Clause 3.1, where NTCIP is referenced twice and Clause 3.1.11.

⁹ NTCIP 9001; the newest version available in September 2002 is Version 3.

4-1 PROJECT-RELATED NTCIP STANDARDS STATUS

The NTCIP standards relevant to this project are shown in the table below.

Table 2: NTCIP-Related Standards & Specifications for the “Mesa ATMS” Implementation

Standard	Description
NEMA TS 3.2–1996 and Amendment 1	Simple Transportation Management Framework (STMF) Conformance Level 2 ¹⁰ .
NEMA TS 3.3–1996 and Amendment 1	Class B Profile
NEMA TS 3.4–1996 and Amendment 1	Global Object Definitions
NEMA TS 3.5–1996	NTCIP Actuated Signal Controller Object Definitions

The Agency, which did not attend NTCIP-related working group (WG) meetings, gained an understanding of the NTCIP suite of protocols through an educational process in working with Vendor and System Integrator. Later in the process, additional understanding was gained upon learning about and using the first version of the NTCIP Guide (NTCIP 9001).

The Vendor based this implementation on their experiences and actual implementation in the neighboring City of Phoenix. Technical revisions and amendments to the relevant NTCIP standards were already integrated during the Phoenix project.

The System Integrator has a long-standing working relationship with the Vendor and is an active participant in the NTCIP standards development arena, and thus had little problems in implementing the NTCIP. In order to achieve the desired level of functionality, many Vendor-specific object definitions (which are generally termed ‘data elements’), especially pertaining to the database upload and download, as well as certain status information, were utilized. However, standardized, NTCIP-defined data elements were used, if they existed to address a particular required function.

5. NTCIP FUNCTIONS AND FEATURES

This section discusses the NTCIP functions and features implemented. NTCIP Conformance Groups and Optional Object Definitions are listed in ANNEX A. Additionally, a number of Vendor-specific data elements to address special functions and the once-per-second communications requirement were created by the Vendor and implemented within the ATMS and the signal controllers.

5-1 OBJECTS & CONFORMANCE GROUPS

All new controllers integrated into the system are “NTCIP-compliant.” This implementation conforms to “Conformance Level 2” as defined in Amendment 1 of TS 3.2-1996.¹¹ SNMP alone could not be used

¹⁰ Initially, only STMP (Conformance Level 1 of the published TS 3.2-1996) was to be implemented. However, changes in the standard required the support of SNMP; essentially requiring conformance level 2 to be implemented.

¹¹ Conformance Level 1 requires support of SNMP, while Conformance Level 2 additionally requires the support of STMP.

because the bandwidth limitations for this project would prevent once-per-second status monitoring when using SNMP. STMP, a much more bandwidth efficient protocol, was able to provide this key feature.

The original specifications did not define the object definitions or conformance groups to be implemented. However during the course of the project, all three parties, Agency, Vendor and System Integrator, agreed on a set of data elements to be implemented. The contract was then modified to reflect these new requirements.

The list of standard data elements implemented for this project is included in Table A-2;¹² Table A-3 shows the data element value ranges supported. This data element set includes most of the object definitions defined within the mandatory and optional conformance groups of NTCIP 1201 (formally known as TS 3.4-1996) and NTCIP 1202 (formally known as TS 3.5-1996). All optional data elements of the conformance groups were implemented. Proprietary data elements were implemented in order to address several functional requirements that were not provided by the standard object definitions. These proprietary data elements addressed some optional conformance group functionalities differently than those defined in the NTCIP standards.

The Vendor-specific data elements also provided additional functions to the mandatory and optional conformance groups as extensions to the standard tables. The Vendor added so-called “block objects” for database management (upload/download of the controller’s database)¹³,¹⁴. The Agency also required status data elements such as a “transition/offset seeking” data element, a “reason for phase termination” data element, and a “door open” data element.

The data elements to control these features were developed by the Vendor. The unique object identifiers (OIDs) for these data elements controlling the non-standardized features are located at the Vendor’s NEMA node address. The Agency has the right to re-use the Vendor-provided MIB for future contracts within the city.¹⁵ These non-standard features will be used in future applications for the Agency, as well as for future implementations by the System Integrator and by the Vendor.

5-2 INTERCHANGEABILITY & INTEROPERABILITY

This system is believed by all parties to provide interoperability among traffic controllers manufactured by different Vendors, assuming the different Vendors follow the rules established in the NTCIP for communications. While this objective has not been truly tested, the System Integrator stated that controllers from different Vendors have been used to validate the interoperability capability during their development process. The Agency believes that the potential of interoperability is certainly much higher than with any proprietary protocol.¹⁶

¹² See Annex A.

¹³ Database management is one of the most important features within a field device. Within a signal controller, manipulating several data elements as a group is critical since the contents are interrelated. Within the NTCIP, there is a standardized mechanism to achieve this, but the implementation provided an additional proprietary mechanism using “block objects”. This is a mechanism where objects are defined using the MIB OBJECT TYPE Macro, but where the value of an object contains a proprietary “message”. These “message” setups are such that each byte, or bit within a byte, or several bytes have a particular meaning. This setup is very similar to the messages used in traditional traffic signal communications protocols.

¹⁴ The “block objects” are specific to each vendor, and each vendor’s controller uses a different set of “block objects.” This means that the central system software must be changed every time a new controller is being added to the system.

¹⁵ Locating object OIDs under the vendor’s node is appropriate and feasible. However, if an Agency requires the development of ‘special’ objects and/or entire MIBs, it may be more feasible to place them under an Agency node to ensure that the control of the object remains with the Agency. If objects are under the vendor’s node, the Agency might need an agreement with the VENDOR to maintain the objects until both sides agree to dismiss them.

¹⁶ At this point, there is no way to tell whether interoperability has indeed been achieved. With only one traffic signal controller manufacturer having supplied equipment for this project and no other NTCIP device on the project, interoperability can neither be confirmed nor denied at this time. Further testing will have to be conducted in order to ensure that interoperability has been achieved.

Interchangeability is being achieved to some degree. This is due, in part, because the Agency developed an Agency-specific set of dynamic objects that are used to populate some of the 13 dynamic objects¹⁷. These data elements are setup using the STMP-defined mechanism.¹⁸ The Agency understands that interchangeability cannot be fully achieved since the upload/download mechanism and corresponding data elements are proprietary. The non-standard data elements developed to address Agency-required functionalities¹⁹ will also cause an interchangeability problem; however, the Agency believes this not to be a problem because it could simply choose not use those data elements.

5-3 THE LEARNING CURVE

While the Agency was very knowledgeable in terms of signal controller functionality, information technology, communications protocols, and software programming, the Agency staff had not actively participated in the development of the NTCIP. In terms of NTCIP, the Agency staff was basically educated by the Vendor and System Integrator. Additionally, the NTCIP Guide proved to be a useful tool.

The Vendor continues to be an active participant in the development of all versions of the NTCIP documents. Therefore, they were very knowledgeable about the data elements, and their meaning. The Vendor's continued participation on these NTCIP Working Groups allowed the Vendor to stay aware of the various implementation and interpretation issues that arose during this project and to raise its own concerns to the relevant NTCIP Working Groups for proper resolution.

Definitions

Interchangeability: the capability to exchange devices of the same device type (e.g., a signal controller from different vendors) without changes to the software beyond updating the appropriate parameters and variables. Some non-standard functions and features might not be available.

Interoperability: the capability to operate devices from different manufacturers, or different device types (e.g., signal controllers and VMS) on the same communications wire/channel.

The System Integrator has significant experience in developing device drivers to communicate with various proprietary protocols and is an active participant in the development of many NTCIP standards. They were very aware of the emerging NTCIP suite of protocols, and actively participated in their development and implementation.

6. TESTING COMPLIANCE

The RFP did not define compliance to NTCIP. During the project, the Vendor defined a set of data elements that the Agency, Vendor, and System Integrator agreed would become the required "de-facto" compliance statement.²⁰ However, the Agency focused on the functions that needed to be implemented and made these the ultimate requirements that had to be confirmed using a 'testing punchlist'.

The Agency was satisfied with the testing process. The Vendor and System Integrator performed the preliminary integration testing in-house at the Vendor's facility, while the main integration testing was

¹⁷ These dynamic objects are not the same as used in Phoenix or Lakewood. Dynamic Objects setups are typically driven by the needs of the Central system; thus, Gardner's Icons system uses different Dynamic Objects than TransCore's Series2000 system (Phoenix, Lakewood).

¹⁸ The STMP mechanism is as defined in TS 3.2-1996, not as modified in TS 3.2 Amendment 1.

¹⁹ The standard allows for such extensions. However, the use of non-standard features prevents full interchangeability. The devices may still be interchangeable with the standard features, but not with the proprietary extensions.

²⁰ This does not necessarily mean that every implementation can, or should, implement all of the propriety objects used in this implementation. The interview did not reveal whether the system could be operated without using these proprietary objects.

performed on-site in the City of Mesa. The Vendor and the System Integrator developed and executed the testing procedures collaboratively.²¹ In addition, the Agency tested communications and timing issues.

6-1 TESTING TOOLS

The RFP did not require the use of any procedures and/or tools.

The project requirements did not call for interoperability testing or certification that such testing was conducted outside the scope of this project. The Vendor conducted compliance testing using several different tools, including DataScan, a 'GET NEXT' tester, and a "suitcase tester." The Vendor designed the GET NEXT tester, which automatically sequences through all data elements, and the suitcase tester,²² which uses dynamic objects to read signal indications, to set parameters, and to read or set other data elements. The suitcase tester was also used to test non-standard NTCIP functionality. The Vendor used the NTCIP Exerciser when questions related to frame constructs arose. The Vendor and the System Integrator compared the frames generated by the NTCIP Exerciser to the ones they developed. The NTCIP Exerciser was also used during development of the testing tools mentioned above. However, the Vendor chose to develop their own testing tools because the NTCIP Exerciser did not meet their needs, especially in terms of the "dynamic objects." They needed a more sophisticated testing tool with a better user interface. The Vendor found it far easier to form frames manually, rather than to use the NTCIP Exerciser.

The System Integrator did use the NTCIP Exerciser, but only sporadically. Instead they relied heavily on a protocol analyzer and tools they developed that provided MIB walking capabilities, dynamic object configuration and polling, and protocol unpacking/viewing.

At the time of the interview, acceptance testing had not yet been performed.

7. USING THE NTCIP

The Agency, System Integrator and Vendor representatives were asked to briefly describe their NTCIP experience.

7-1 FROM THE AGENCY'S PERSPECTIVE

The Agency described their experience as "just like anything, a learning experience." From the Agency perspective, the standards were not specific enough to provide a "standard" implementation. For example, all devices added to the system require proprietary items such as "block objects" and upload/download mechanisms. These proprietary data elements are likely to be different for each Vendor's equipment.

The Agency's primary concerns whether sufficient bandwidth existed and whether the system is really interoperable. Additionally, the not-yet-implemented city-to-city connectivity was a concern. In hindsight, the Agency's main objective regarding achieving interoperability²³ among controllers was realistic and has been achieved. The next implementation of the NTCIP should be even smoother. The concern regarding

²¹ Leaving it up to the Vendor and System Integrator could lead to problems when other devices or device types are being added to the system. The interpretation of the NTCIP has to be unambiguous to guarantee that systems can provide interoperability and interchangeability.

²² A suitcase tester is a testing tool contained in a briefcase or suitcase for portability.

²³ Interchangeability was dropped, after it became clear that each vendor would use proprietary objects to achieve some functionalities.

bandwidth limitations turned out to be the biggest challenge, but ultimately it has been resolved by upgrading the modems to full-duplex 9600 bps and alternative wireless solutions.

The Agency also took steps to prepare their maintenance staff for the new system, a problem which is all too often forgotten or oftentimes an after-thought. The maintenance staff was involved in developing the RFP and received advanced formal training in the new signal control and TMC equipment.

7-2 FROM THE VENDOR'S PERSPECTIVE

The Vendor did not anticipate any major problems during the implementation of this project due to its experiences and the knowledge that problems were already resolved during the previous City of Phoenix project. The NTCIP Amendments had addressed several problems encountered during that previous project, and this implementation helped to further stabilize the controller software. The experiences were also different because of a different System Integrator; this project was almost painless.

However, it was determined that the time-related data elements as defined in NTCIP 1201 – Amendment 1 were ambiguous in terms of the sequence for setting those data elements²⁴. So, the Vendor discussed the issue with other Vendors to come to a common solution, and the consensus approach was subsequently implemented in this project.

The Vendor is committed to the NTCIP, but sees the ever evolving standards as a problem in terms of resource commitment.²⁵ They will propose the use and support of the NTCIP, even if it is not required per the specifications. The need to maintain different software bases for their distributed systems (NTCIP-based communications) and their closed-loop systems (proprietary-based) was cited as a problem²⁶.

7-3 FROM THE SYSTEM INTEGRATOR'S PERSPECTIVE

The System Integrator already supported as many as five different versions of the NTCIP for different projects and did not have any reservations when getting into this project. They believe that NTCIP is the future in terms of communications protocol within the transportation industry and stressed that the company is very much vested in using the NTCIP. The System Integrator indicated that their expectations were correct.

8. LESSONS LEARNED

8-1 FOR AGENCIES

During the interviews, the following recommendations were made for an Agency preparing for an implementation:

- Gain a thorough understanding of the NTCIP.²⁷

²⁴ This ambiguity has not yet been resolved within NTCIP 1201, and may cause interoperability problems down the line.

²⁵ For example, the Version 2 of NTCIP 1202, which is anticipated for release in late 2002/early 2003, will require the rewrite of certain parts of the controller software.

²⁶ The NTCIP 1210 standard (Field Management Station), which includes the object definitions for on-street master controllers, was released for User Comment in August 2002.

²⁷ The documents posted on the NTCIP web-site, and discussions with the Vendor and System Integrator helped the Agency understand the NTCIP.

- Consider hiring a knowledgeable consultant to guide NTCIP implementation and conformance testing.
- Review and customize specifications that require the support of the NTCIP.
- Understand the capabilities and limitations provided by the NTCIP suite of protocols.

8-2 FOR VENDORS / SYSTEM INTEGRATORS

Purposely left blank.

8-3 RECOMMENDATIONS FOR IMPROVEMENTS TO THE NTCIP STANDARDS

- **Develop Automatic Compliance Testing procedures.**
- **Develop realistic test-plans** or testing procedures to help compliance testing and conformance. However, the Agency does understand that this may be a daunting, if not impossible task, considering the complexities and possible implementation deviations in terms of both desired functionalities and supporting communications protocols.
- **Develop and provide a set of testing software.**
- **Develop a high-level Executive NTCIP Guide for use by decision makers.** The need to implement high-speed communications media should be pointed out in this document.
- **Standardize the block objects** or, as a minimum, the approach to block objects.²⁸
- **Update the NTCIP Exerciser**, since it is not useful in its current format.
- **Develop new standards for video detection** (the NTCIP 1209 [TSS] is not sufficient) **and for SCADA systems.**

8-4 THE NTCIP JOINT COMMITTEE AND FHWA

- **Maintain Standards and Guide documents**
 - Maintain an updated NTCIP Guide because it is one of the most valuable tools in explaining the capabilities and limitations of the NTCIP suite of protocols.
 - Maintain the standards and provide funding to support this maintenance effort (volunteer efforts across 3 SDOs might not work).
 - Integrate implementation findings into the standards as quickly as possible.
- **Increase outreach and education**
 - Inform customers, especially the public sector, of the benefits in participating in working groups defining functional requirements.
 - Develop a high-level presentation and brochures to explain the NTCIP but also general issues associated with NTCIP.

²⁸ The Block Objects are being standardized in Version 2 of NTCIP 1202.

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- Tailor courses to the audience / specific groups (high-level; engineers; technicians)
 - Add real life implementation and testing examples.
 - Encourage more public sector participation early on in the individual standards development process.²⁹
 - Present a realistic picture of the NTCIP in outreach programs; avoid presenting the NTCIP with a “marketing” spin.
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- **Develop sample procurement specifications**, while at the same time intensifying the outreach and education to avoid people using the specs as boilerplate, cut and paste material.
 - **Certification is not seen as efficient** because of varying requirements, communications infrastructures, and protocols, and because most agencies will test any new machines anyway.

²⁹ It should be noted that the SDOs have strived since the beginning of the NTCIP standards development effort to balance the membership in each working group to be at least 9 people, 3 from Public Sector, 3 from Vendors, and 3 from System Integrators, consultants.

ANNEX A: NTCIP EQUIPMENT DESCRIPTIONS

Table A-1: Existing and New Equipment

Equipment information	Before project non-NTCIP	After project Non-NTCIP	After Project NTCIP
Number of devices	313	N/A	82 (ultimately all 313)
Device Types	<u>SIGNAL CONTROLLERS:</u> Sonex		<u>SIGNAL CONTROLLERS:</u> Econolite ASC/2
Controller Connection	Multi-drop, mini-computer ('mainframe') based System	N/A	Multi-drop, Distributed PC-based System

Table A-2: NTCIP Conformance Groups Implemented for Signal Systems

Conformance Group	Reference Standard	Conformance Status	CAPABILITIES	
			Requested	Implemented
Configuration	TS 3.4	Mandatory	Not specified	V=Y / SI=Y
Database Management	TS 3.4	Optional		V=Y
Time Management	TS 3.4	Optional		V=P / SI=Y
Timebase Event Schedule	TS 3.4	Optional		V=P
Report	TS 3.4	Optional		V=P
STMP	TS 3.4	Optional		V=Y
PMPP	TS 3.4	Optional		V=N
Phase	TS 3.5	Mandatory		V=Y / SI=partially
Detector	TS 3.5	Mandatory		V=Y / SI=partially
Vehicle Occupancy Report	TS 3.5	Optional		V=Y / SI=Y
Unit	TS 3.5	Optional		V=Y / SI=partially

Conformance Group	Reference Standard	Conformance Status	CAPABILITIES	
			Requested	Implemented
Special Function	TS 3.5	Optional		V=Y / SI=partially
Coordination	TS 3.5	Optional		V=P / SI=partially
Time Base	TS 3.5	Optional		V=P
Preempt	TS 3.5	Optional		V=P
Ring	TS 3.5	Optional		V=Y
Channel	TS 3.5	Optional		V=Y
Overlap	TS 3.5	Optional		V=Y / SI=partially
TS 2 Port 1	TS 3.5	Optional		V=Y

Note 1: V=Vendor, P = Private objects, SI=System Integrator, partial=a mix of mandatory and optional objects of a conformance groups were used, but not all mandatory objects were needed and therefore not supported.

Note 2: Portions of Coordination objects were supported (being able to command coordination were implemented using standard objects)

Table A-3: ECONOLITE ASC/2 Series Controller NTCIP Support

In addition to the above description, the Vendor provided the following information (*excerpt without any changes*) regarding the objects and the object ranges that are supported in this implementation. While providing this information deviates from the approach taken in other case studies, the authors felt this information was too important. However, the implementation also implemented a large number of proprietary objects, which are not provided due to intellectual property rights issues.



Econolite is currently supporting NTCIP Class B communications in the ASC/2 Series controllers. The level of NTCIP support is as defined in the new NEMA TS2 specification recently approved by NEMA. The specification defines NTCIP Level 1 and Level 2 compliance for actuated controllers. A summary of the NEMA Level 1 and Level 2 compliance for actuated controllers, as set forth in the new TS2 standard, is included as an attachment to this document.

The ASC/2 controller can support system operation using the ASC/2 Level 1 NTCIP objects plus the ASC/2 private objects. Econolite NTCIP software for the ASC/2 controller is currently NEMA NTCIP Level 1 compliant (ASC/2 NTCIP software is currently undergoing integration testing for the Phoenix, AZ; Lakewood, CO; and Salt Lake City, UT ATMS projects). The ASC/2 Level 1 NTCIP software also supports the following optional conformance groups: Database Management as defined in TS 3.4, and Volume Occupancy Report, Unit, Special Function, Ring, Channel, Overlaps and TS2 Port 1 as defined in TS 3.5. Attached is a list of objects currently supported by the ASC/2 NTCIP Level 1 controller software.

The NTCIP optional Coordinator, Preemption and Timebase conformance groups are not supported with ASC/2 NTCIP Level 1 compliant software. However, all ASC/2 Coordinator, NIC, Time-of-Day, Holiday and Preemption functions are supported using private objects.