
NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL
CASE STUDY REPORT

NTCIP 9004-Amendment 1 v06

City of Phoenix, Arizona Phoenix Advanced Transportation Management System

Amendment 1 version 06, January 2003. A Recommended Information Report of the Joint Committee on the NTCIP.

© 2003 AASHTO / ITE / NEMA. All rights reserved. Permission to copy without fee all or part of this Information Report is granted for the following noncommercial use, without editing or modification: (a) downloading the electronic file, and making up to 30 copies of the file by electronic mail distribution or disk reproduction; (b) printing one copy, and reproducing and distributing up to 30 printed copies; and (c) excerpts limited to 5 or fewer pages. Provided that all the foregoing use includes the © AASHTO / ITE / NEMA copyright notice; along with a notice that the copy is reprinted with permission; and along with the title, document number, and date; all of which appear on each copy. Permission is not granted for the following use: (i) republishing in compendiums or anthologies; (ii) publishing excerpts in commercial publications or works for hire; (iii) display in electronic storage devices or methods on networks; and (iv) in translations to other languages. Other use requires prior written consent; see the Request form in the www.ntcip.org Library.

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 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. CASE STUDY UPDATE

The initial deployment of NTCIP-conformant equipment by the City of Phoenix, Arizona (Agency) was documented in a case study of their Advanced Transportation Management System (ATMS) implementation in NTCIP 9004 Version 01.05, dated November 16, 1999. The focus of that case study was the implementation of signal controllers conforming to the NTCIP 1202 – NTCIP Actuated Signal Control (ASC) standard. Now that some time has elapsed since that initial effort, AASHTO, FHWA, ITE, and NEMA are sponsoring this case study update. This effort, presented as a case study amendment, focuses on insights gained over the three years of deployment since the initial case study was performed. Specifically, this amendment will address Agency issues concerning current implementation efforts and their needs based upon experience gained through NTCIP deployment experience.

2. RECENT NTCIP IMPLEMENTATION EFFORTS

The original project called for more than 1000 signalized intersections and approximately 350 traffic cabinets to be replaced in a staged effort over multiple years and purchases. The city was replacing its existing UTCS-based system, installed in the 1970s, with a new distributed control system. A direct-connect, multi-drop communications network (1200 bps, half-duplex) is used to communicate with the signal controllers. The project was to be implemented in the following phases:

- Phase 1: Phoenix ATMS was developed to control AB 3418-compliant signal controllers that were to be installed at 57 downtown intersections.
- Phase 2: Phoenix ATMS development continued. Real-time status monitoring via once-by-second communications and NTCIP, download/upload capabilities were added. Vendor traffic signal controllers were integrated into the ATMS.
- Phase 3: Integration continued. Real-time status monitoring and upload/download functionality to be added to allow communication with controllers from a second Vendor.
- Phase 4: Bids to be solicited for an additional set of signal controllers from a third Vendor.

At the time of this update in Spring of 2002, the city was in the process of finalizing Phase 3. The integration period to get the second vendor on-board and integrated has taken roughly two years. All aspects of the project through this third phase were executed, except for the System Acceptance Testing (SAT). The SAT will be performed on 8 of the 400 intersections at which the second Vendor's product was installed.

As of Spring of 2002, Phase 4 was not initiated and, due to the current interoperability problems associated with the NTCIP standards for signal control, as well as the resulting costs for customizing the Central System software, it may be delayed for quite some time.

At the time of this update, the city is planning on adding other devices, particularly NTCIP-compliant Dynamic Message Signs (DMS), to the ATMS. These signs will be connected via dial-up connections (most will be wireline, while one sign will be connected via wireless using cellular technology). Adding these signs with their communications infrastructure will require different NTCIP communications protocols to be integrated into the ATMS. The protocols to be used are:

- Application Profile layer - NTCIP 2301 – Same as for signal control but without the need for Conformance Level 2 (only SNMP but not STMP).
- Transport Profile Layer - It is not quite clear whether the routable NTCIP standard (NTCIP 2202) or the non-routable NTCIP standard (NTCIP 2201) will be used.
- Subnetwork Profile Layer - NTCIP 2103 – This is different from the communications for the signal controllers where all controllers are connected in a multi-drop fashion.

2-1 CURRENT PROCUREMENT PRACTICES

The Agency extended the System Integrators contract via a change order to include the second Vendor's product into the ATMS. A separate contract was issued to the second Vendor (Peek Traffic Systems).

2-2 CURRENT SPECIFICATION CHANGES

This project was the first contract requiring the use of NTCIP for the new signal controllers and the ATMS. The original specifications were issued before the NTCIP standards were published or even in their final format, and required that the bid respondents work with the Agency to provide NTCIP for signal control without further details on what this means. This approach did not work very well, resulting in many change orders, delays, and extensive coordination between the System Integrator and the Vendor.

After learning from the experiences of Phase 1 and with the availability of other examples, the Agency added specific language as well as specific milestones to the contract with the second Vendor (see Annex A).

For Phase 3, the Agency utilized the same version of NTCIP 1201 and 1202 as for Phase 2. However, the vendors included the details of Amendment 1 to NTCIP 1201, 1202, 2301 and 2101 into the products. The Agency was not aware of the existence of Version 2 for NTCIP 1202, which added the Block Object definitions,¹ but it will now investigate this new version.

2-3 OTHER PROJECT ISSUES

Over the course of the project, several changes occurred. One of the most significant and challenging changes was that the Agency project team was completely replaced due to turnover of the key employees. While the new staff has significant experience in project management, the need for understanding a communications protocol was new, and the project manager had to learn the NTCIP requirements and their implications from scratch. Adding to this challenge, the second Vendor also went through a re-location and re-structuring process.

3. LESSONS LEARNED / FUTURE NEEDS

Based upon their experience to-date, the Agency has determined that the installed controllers do not satisfy one of the primary goals of NTCIP, interchangeability. At the time of the update development in spring of 2002, the other primary goal of interoperability has not yet been tested. As for interchangeability, the Agency understands that due to the customization of the central system (ATMS), it will not be able to simply add products from other vendors to their system.

This limitation that can be attributed to the signal control-related NTCIP standards led to the Agency's comments on the NTCIP standards. The Agency is disappointed with the standards because they do not fulfill the perceived interchangeability goals promised. Specifically, the following comments and potential enhancement suggestions for the NTCIP Standard 1202 were provided:

1. System Detector issues (Volume, Occupancy, Period):
 - The setting of time periods and collection of data are not consistent with good operational practices.
 - Collection of time within cycle (top of cycle often used) may not correspond to the controller-buffering period.

¹ The Block Objects are basically pre-defined Dynamic Objects that organize 1201 and 1202-defined objects into logical blocks. The block objects are intended to replace the current practice of using vendor-specific 'memory image' blocks to populate configuration items such as basic configuration items (sequence definitions, preempt definitions, etc) and timing sheets.

2. Need for a standard object to indicate whether the controller is in transition from one timing plan to another.
3. Need for a standardized download request.
4. The lack of a standardized upload/download method required manufacturer-specific implementations.²

The System Integrator indicated that true interchangeability is prevented due to the following reasons:

1. Different operational modes for the controllers
2. Different controller database requirements—Both vendors implemented a large number of proprietary objects for controller definition. These proprietary objects were in addition to the "logical blocks" of data required for database upload/download.
3. Different controller operational characteristics
4. The necessity to use proprietary objects for efficient database upload/download

However, the central system does not use different device drivers for each vendor. The only change required to device communications was dictated by changes between 1101:1996 and 1101:1996A1. The change was restricted to creating dynamic objects within the controller. The first controller Vendor implemented the dynamic object methodology defined in 1101:1996, while the second Vendor used the methodology defined in the 1998 Amendment to 1101:1996. From a communications perspective, however, the controllers are completely interchangeable.

3-1 TESTING FOR NTCIP CONFORMANCE

In respect to testing, the agency expressed the opinion that NTCIP conformance testing should not be its responsibility. The vendors and system integrators should be able to get the products certified by an independent testing house that is sponsored by themselves and FHWA. The agency should be able to purchase certified NTCIP compliant controllers and systems from vendors and system integrators without the burden of NTCIP testing.

3-2 FINAL THOUGHTS

If they could do it all over again, the Agency would not require the use of NTCIP, because they feel that the current version of NTCIP 1202 standard is not mature, which leads to the long implementation phase and the excessive change orders. The need to supervise a project is already a challenge, but to allocate staff just for the sake of the communications protocol was seen as an undue burden.

² Note that Version 2 of NTCIP 1202 includes a standardized upload/download methodology.

ANNEX A: MODIFIED NTCIP CONTRACT LANGUAGE

The City of Phoenix modified the specification / contract language that was included in the contract for the 2nd vendor. The NTCIP language was much more extensive than the original requirements and it included the delivery milestones.

However and unfortunately, at the time of this update, this updated language was not available in electronic format. Please contact Mr. Bob Steele, the ITS Manager for the City of Phoenix, for further information at 602-262-6136 or by e-mail at bob.steele@phoenix.gov.

§