
NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL
CASE STUDY REPORT

NTCIP 9007 v01.05

**City of Mesa, Arizona
Signal System Upgrade**

version 01.05, January 2003. A Recommended Information Report of the Joint Committee on the NTCIP.

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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.

-
- 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.
- **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.

Although coordination is supported using private objects, three objects from the NTCIP Coordinator conformance group are supported: “coordPatternStatus”, “localFreeStatus” and “systemPatternControl”. See the *ASC/2 Programming Manual and Appendix B*.

Econolite can supply copies of the ASC/2 MIBs if required by project specifications.

The ASC/2 NEMA NTCIP Level 1 compliant software supports the Object Requirements as indicated in the table below.

Table 1 –Object Requirements

Object	Object Requirements
TS 3.4	
<i>moduleType</i>	Value 3
<i>dbCreateTransaction</i>	All Values
<i>dbErrorType</i>	All Values
<i>globalDaylightSaving</i>	Values 2 & 3
<i>The timebase functions are implemented using private objects. The full ASC/2 NIC, Time-of-Day and Holiday programming operation is supported. Please see the ASC/2 Programming Manual and Appendix B. NEMA NTCIP timebase operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</i>	
<i>maxTimeBaseScheduleEntries</i>	Future Level 2 (1999)
<i>maxDayPlans</i>	Future Level 2 (1999)
<i>maxDayPlanEvents</i>	Future Level 2 (1999)
<i>maxEventLogConfigs</i>	Future Level 2 (1999)
<i>NEMA NTCIP event log recording will be supported with the future NTCIP Level 2 software. The ASC/2 now logs controller, detector and MMU. Our NTCIP Level 1 software will be capable of returning these logs using private objects.</i>	
<i>eventConfigMode</i>	Future Level 2 (1999)
<i>eventConfigAction</i>	Future Level 2 (1999)
<i>maxEventLogSize</i>	Future Level 2 (1999)
<i>maxEventClasses</i>	Future Level 2 (1999)
<i>maxGroupAddress</i>	Future Level 2 (1999)
TS 3.5	
<i>maxPhases</i>	12
<i>phaseStartup</i>	Values 2 thru 6
<i>phaseOptions</i>	All Values
<i>maxPhaseGroups</i>	2
<i>maxVehicleDetectors</i>	64
<i>vehicleDetectorOptions</i>	All Values
<i>maxPedestrianDetectors</i>	12
<i>unitAutoPedestrianClear</i>	All Values
<i>unitControlStatus</i>	All Values
<i>unitFlashStatus</i>	All Values
<i>unitControl</i>	All Values

Object	Object Requirements
maxAlarmGroups	2
maxSpecialFunctionOutputs	8
<p>The coordination functions are implemented using private objects. The full ASC/2 coordinator is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP coordinator operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
coordCorrectionMode	Values 2 thru 4
coordMaximumMode	Values 2 thru 4
coordForceMode	Values 2 & 3
maxPatterns	64
patternTableType	2
maxSplits	12 (one per phase)
splitMode	Values 2 thru 7
localFreeStatus	Values 2 thru 6. The ASC/2 coordinator takes other corrective action to handle bad cycle lengths and out-of-range offsets.
<p>The timebase functions are implemented using private objects. The full ASC/2 NIC, Time-of-Day and Holiday programming operation is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP timebase operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
maxTimebaseASCActions	The ASC/2 supports timebase operation using private objects, which offer 200 NIC steps and 100 time-of-day steps. Appendix B lists all private timebase related objects. Please refer also to the <u>ASC/2 Programming Manual</u> .8
<p>The preemption functions are implemented using private objects. The full ASC/2 preemptor, including priority and bus preemption, is supported. Please see the <u>ASC/2 Programming Manual</u> and Appendix B. NEMA NTCIP preemptor operation will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.</p>	
maxPreempts	6 plus 4 bus_
preemptControl	Private objects.
preemptState	Private objects.
maxRings	2
maxSequences	The ASC/2 uses the Alternate Sequence operation as defined in the NEMA TS2 specification that essentially supports 16 sequence plans. NEMA NTCIP sequence control will be supported in the future release of ASC/2 NTCIP Level 2 compliant software.
maxChannels	16
channelControlType	Values 2 thru 4
channelFlash	Values 0, 2, 4, 6, 8, 10, 12, & 14
channelDim	Values 0 thru 15
maxChannelStatusGroups	2
maxOverlaps	4
overlapType	Values 2 & 3

Object	Object Requirements
maxOverlapStatusGroups	1
maxPort1Addresses	18
port1Status	Values 2 & 3

Enhancements

1. *Extended detector alarm capability provides for up to three different detector alarm periods each day for each of 64 detectors. The NTCIP specification requires only one alarm period.*
2. *Extended objects support the complete set of ASC/2 Phase, Detector and Overlap functions. Please see Appendix B for a listing of all supported objects.*
3. *Because upload and download operations are very slow using 1200 bps data rates, Econolite supports block upload and download of the ASC/2 database using private MIBs.*

Table A-4: SIEMENS Gardner Transportation Systems ICONS NTCIP Support

In addition to the above description, the System Integrator (by way of the City) 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 central system also implements a few Vendor-proprietary objects, which are not provided due to intellectual property rights issues.

NTCIP Name(s)
2.2.4.4 Phase Status Group Greens (Phases 1-8)
2.2.4.4 Phase Status Group Greens (Phases 9-16)
2.2.4.4 Phase Status Group Greens (Phases 17-24)
2.2.4.4 Phase Status Group Greens (Phases 25-32)
2.2.4.4 Phase Status Group Greens (Phases 33-40)
2.2.4.6 Phase Status Group Pedestrian Clears (Pedestrian 1-8)
2.2.4.7 Phase Status Group Walks (Pedestrian 1-8)
2.2.4.6 Phase Status Group Pedestrian Clears (Pedestrian 9-16)
2.2.4.7 Phase Status Group Walks (Pedestrian 9-16)
2.5.10 Coordination Pattern Status
2.4.1 Global Time Parameter
2.10.4.3 Overlap Status Group Yellows (Overlap 1-8)
2.10.4.4 Overlap Status Group Greens (Overlap 1-8)
2.3.4.2 Detector Status Group Active (Detectors 1-8)
2.3.4.2 Detector Status Group Active (Detectors 9-16)
2.3.4.2 Detector Status Group Active (Detectors 17-24)
2.3.4.2 Detector Status Group Active (Detectors 25-32)
2.4.6 Unit Flash Status

Annex A – Project-Specific NTCIP Items

NTCIP Name(s)
2.4.9 Short Alarm Status
2.3.5.1 Volume / Occupancy Sequence
2.3.5.2 Volume / Occupancy Period
2.3.5.4.1 Volume Data
2.3.5.4.2 Occupancy Data
2.4.14.2 Special Function Output Control
2.5.14 System Pattern Control
2.3.1 Database Create Transaction
2.3.6 Database Verify Status Parameter

Table A-5: Supported Communications Object Definitions

Conformance Group	Reference Standard	Conformance Status	CAPABILITIES	
			Requested	Implemented
RFC 1213-MIB – data elements	TS 3.3	Mandatory	Not specified	V=Y / SI=N
atTable data elements				V=N / SI=N
netToMediaTable-data elements				V=N / SI=N
RFC 1317-MIB – data elements	TS 3.3	Mandatory		V=Y / SI=N
RFC 1381-MIB –data elements	TS 3.3	Mandatory		V=Y / SI=N
Support of Traps	TS 3.3	Optional		V=N / SI=Y
STMP	TS 3.4	Optional		V=Y / SI=Y
PMPP	TS 3.4	Optional		V=N / SI=Y

Table A-6: Supported Communications Equipment and Communications Speeds

TECHNOLOGY	1200 bps	2400 bps	9600 bps	14.4 Kbps	19.2 Kbps	56 Kbps	COMMENTS
Multi-drop, half duplex	SI	SI	SI	SI	SI	SI	
Multi-drop, full duplex	SI	SI	V, SI	SI	SI	SI	

TECHNOLOGY	1200 bps	2400 bps	9600 bps	14.4 Kbps	19.2 Kbps	56 Kbps	COMMENTS
Dial-up - Wire-line							
Dial-up - Wire-less							
OTHER Microwave Spread spectrum PPP phone PPP phone over fiber PMPP wireless MAS Licensed Radio CDPD				SI			microwave for CCTV not yet installed TCP/IP over Ethernet, ATM, Frame Relay, other IP delivery mechanisms

Vendor: Only Class B Profile was implemented.

ANNEX B: REQUEST FOR PROPOSAL**CITY OF MESA, ARIZONA**
REQUEST FOR PROPOSAL FOR
ADVANCED TRAFFIC MANAGEMENT SYSTEM
(REQUEST FOR PROPOSAL #XXXXX)**GENERAL TERMS AND CONDITIONS**

NOTICE IS HEREBY GIVEN that sealed proposals will be received by the City of Mesa until 3:00 P.M., March 27, 1998, for furnishing an Advanced Traffic Management System for the Mesa Transportation Division.

Proposals must be in accordance with the provisions, specifications and bidding instructions set forth herein and will be received by the Purchasing Division until the above noted time, when they will be publicly opened and acknowledged.

Each Vendor shall submit five (5) copies of the Proposal in a sealed envelope marked "PROPOSAL ON ADVANCED TRAFFIC MANAGEMENT SYSTEM" and must be received by the Purchasing Division on or before 3:00 P.M., Mountain Standard Time. Proposals that are mailed shall be addressed to the City of Mesa Purchasing Division, P.O. BOX 1466, Mesa, Arizona, 85211-1466. Proposals that are delivered in person or by courier shall be sent to the street address, 20 E. Main Street, Suite 150, Mesa, Arizona, 85201. No responsibility will attach to the City of Mesa, its employees or agents for premature opening of a proposal that is not properly addressed and identified. Telephone, telefax, or e-mailed proposals will not be accepted.

A mandatory pre-proposal conference will be conducted at 1:30 P.M. on March 23, 1998 in the Transportation Training Room, 320 E. 6th Street, Mesa, Arizona, for the purpose of reviewing the terms, conditions, specifications and scope of work in the proposal. The City will also answer any questions or clarifications pertaining to the RFP. Vendors should submit all questions via fax or in writing by March 16, 1998 to Sharon Seekins, Purchasing Administrator, fax number (602) 644-2655; P.O. Box 1466, Mesa, Arizona 85211-1466.

All telephone or personal contacts regarding information concerning this proposal must be made with the Buyer Aide, Monica Dmuchowski, at the address above or by telephoning (602) 644-2546.

1 ADDITIONAL CONDITIONS OF PURCHASE**1.1 AFFIRMATIVE ACTION IN EMPLOYMENT**

Any Contractor in performing under the contract shall not discriminate against any worker, employee or applicant, or any member of the public because of race, creed, color, age, religion, sex, national origin, or disability (as defined by the Americans with Disabilities Act) nor otherwise commit an unfair employment practice. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are dealt with during employment without regard to their race, creed, color, age, religion, sex, or national origin. Applicants or employees with disabilities covered by the Americans with Disabilities Act shall be dealt with in accordance with ADA requirements. Affirmative Action and accommodations for the disabled shall include, but not be limited to the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, selection for training and/or apprenticeship. The Contractor further agrees that this clause will be incorporated in all subcontracts entered into with suppliers of materials or services, and all labor organizations furnishing skilled, unskilled, and union labor, or who may perform any such labor or service in connection with this contract.

1.2 DRUG FREE WORKPLACE PROGRAM

Offerors are hereby advised that the City of Mesa has adopted a policy establishing a drug free workplace for itself and as a requirement for Sellers/Contractors doing business with the City, to ensure the safety and health of employees working on City contracts/projects.

Any Seller/Contractor who is awarded a contract for all or any part of a project totaling \$25,000 or more shall require a drug free workplace for all employees working under the contract. Specifically, all employees of the Seller/Contractor who are working under a contract with the City of Mesa shall be notified, in writing, by the Seller/Contractor that they are prohibited from the manufacture, distribution, dispensation, possession or unlawful use of a controlled substance in the workplace.

Failure to require a drug free workplace in accordance with the Policy may result in termination of the contract and possible debarment from bidding on future City of Mesa contracts/projects.

1.3 F.O.B. POINT & RISK OF LOSS

Proposal prices shall be F.O.B. the City of Mesa's designated jobsite(s) as specified by our purchase order.

The Contractor agrees to bear all risks of loss, injury, or destruction of goods or equipment incidental to providing these services which occurs prior to delivery to and acceptance by the City; and such loss, injury, or destruction shall not release Seller from any obligation hereunder.

1.4 ALTERNATE BIDS

Unless the enclosed specification and/or bid form are marked "NO SUBSTITUTE," the words "or equal" are understood whether stated or not after each article giving manufacturer's name or catalog reference or on any patented article. Where brand names or manufacturer's names are used in these documents, they are intended to establish a standard of quality of goods and materials, equipment function, and/or process. There is no intent to limit competitive bidding. The decision of the City of Mesa as to whether an alternate or substitution is in fact "equal" shall be final. If bidding on items other than those specified, Vendor must in every instance give the trade designation of the article, manufacturer's name, and detailed specifications of items to be furnished. Otherwise, the bid will be construed as submitted on the identical item as specified. Unless otherwise specified, all equipment, rolling stock, accessories and optional items listed herein shall be the manufacturer's standard product or design. Any modifications, alterations or after market additions proposed by the Contractor shall be fully disclosed as part of the bid.

The Vendor shall state if the goods, materials, and services being bid comply with the bid specifications. If the goods, materials, and services being bid vary in any part from the specifications, the Vendor will list specifically the deviations. Failure to comply in this regard will, if detected, result in having the Vendor's bid rejected. If the failure of the Vendor to disclose deviations is not detected prior to the City making an award to the successful Vendor and receiving goods, materials, and services pursuant to the contract, the City shall have the right to terminate the contract after ten (10) days notice to the Contractor, during which time the Contractor shall have the right to present whatever evidence or information it has that the goods, materials, and services do not deviate from the specifications. If the Contractor does not contest the fact that the goods, materials, and services deviate from the specifications within the ten (10) day period, or if after hearing from the Contractor the City makes a determination that goods and materials do vary from the specifications, with the City's determination being final, the City shall have the right to retain all goods, materials, and services received from the Contractor with payment only for the goods and materials received which meet specifications. The City may also remove the offending Contractor from the bid list for future consideration for a period of time not to exceed three (3) years.

1.5 CONTRACT ADMINISTRATION

The City's official representative during the procurement process is the City Purchasing Administrator. After execution of a contract, the City will be represented by the City Signal Systems Supervisor. All questions regarding this contract shall be referred to an official representative for resolution.

Addenda issued during the time of bidding shall be attached to and made part of the contract documents.

Supplements may be written to the contract for the addition or deletion of services. Payment will be negotiated and determined by the Contract Administrator(s).

1.6 EXECUTION OF CONTRACT

To execute a contract, the City will require the successful Vendor to sign all documents required by the City. This would include, but is not limited to the Contract Agreement forms. The Vendor shall also provide the necessary performance and payment bonds, and evidence of insurance as required under the contract documents. No work shall commence until all contract documents are signed.

No contract awarded pursuant to a proposal submitted in response to this request may be assigned either in whole or in part without first receiving written consent of the City. Any attempted assignment, either in whole or in part, without such consent shall be null and void and in such event the City shall have the right at its option to terminate the contract. Further, no contract for this project may be signed by the City without the prior authorization of the Mesa City Council.

Mesa's signal system project will be completed in phases with the minimum as identified below:

Proposal and Contract Agreement

Operational Test

Implementation

Final Acceptance

1.7 TERMINATION AND OTHER REMEDIES

Default: The City reserves the right to terminate any part or all of the contract resulting from this Request for Proposal if the Contractor fails to carry out any term, promise, or condition of the contract. The City will issue a written ten (10) day Notice of Default to the Contractor if in the opinion of the City, the Contractor:

Provides materials and/or services that do not meet the requirements of the contract or if he/she attempts to impose products, service or workmanship that are of unacceptable quality;

Fails to complete the required work or fails to perform required services within the time frame stipulated;

Fails to make progress to perform the contract requirements and/or gives the City an indication that he/she will not or cannot perform the requirements of the contract.

Failure of the Contractor to remedy the problems noted or to otherwise bring performance to satisfactory levels that are within the requirements of the contract shall give the City cause to cancel this contract. The Contractor will be provided with a written cancellation notice that specifies the effective date of the cancellation. After receipt of the Notice of Cancellation, the Contractor agrees to perform the terms and conditions of this contract up to and including the date of cancellation as though no cancellation has been made. In case of Default and/or Cancellation, the City reserves the right to purchase from the open market, or to complete the required work or have it completed at the expense of the contractor. The City may recover any actual excess costs by (1) deduction from an unpaid balance due; (2) collection against the proposal and/or performance bond; or (3) a combination of the aforementioned remedies or other remedies as provided by law.

Conflict of interest: The City Manager or his authorized agent may cancel any resulting contract(s) from this request within three years after award, without penalty or further obligation, if any person significantly involved in initiating, securing, drafting, or creating the contract for the City of Mesa becomes an employee or agent of the Contractor as defined by A.R.S. 38-511.

Termination for convenience: The City reserves the right to terminate any resulting order or contract upon sixty (60) days written notice. The City will be responsible only for those services which have been delivered and accepted.

In the event that through legislative or judicial actions this type of enforcement becomes illegal, the City has the right to immediate termination of the contract.

In addition to termination or in the alternative, the City may pursue any or all other legal and equitable remedies and rights it may have under the circumstances.

1.8 QUANTITIES, FUNDS APPROPRIATION

Where quantities or performance frequencies are listed, they represent the City's best estimate of current requirements, but shall not bind it to purchase, accept or pay for services more than its actual needs nor for any item for which funds are not available. The City reserves the right to purchase additional quantities of any goods and services shown in this bid request at the price within 36 months of the bid award.

The City reserves the right to procure the services set forth herein from other sources when deemed necessary and appropriate. If funds are not appropriated to continue this agreement and for the payment of charges hereunder, the City may terminate this agreement at the end of any fiscal period, but agrees to notify, the contractor regarding the non-appropriation at least thirty (30) days prior to the end of the fiscal period. The City will pay the Contractor all charges incurred through the end of such period.

1.9 PERFORMANCE QUALITY STANDARDS

Upon request, Offerors are required to furnish a sample of the goods and materials and/or service to be supplied. Any sample submitted shall create an express warranty that the whole of the goods and materials and/or service shall conform to the sample submitted. All samples become the property of the City at no charge unless designated otherwise by the Offeror.

If desired by the City, goods and materials or services proposed shall be subjected to testing, dissection or analysis by a recognized testing laboratory or City staff to determine either the "equality" of alternate goods and materials or services proposed or furnished as compared with the goods and materials or services specified, or the comparative value of different or similar goods and materials or services proposed or furnished by the same offeror or competing offerors. If the goods and materials or services are tested by a laboratory, the cost shall be borne by the Vendor.

If any work which is scheduled for performance is omitted or done in a substandard or unsatisfactory manner, the Contractor at no additional charge to the City, will redo this work until compliance with this contract is met to the satisfaction of the City. The City may, at its option, waive this requirement if deemed appropriate and upon receipt of a specific request by the Contractor.

1.10 WARRANTIES

Unless otherwise specified, all goods and materials delivered or services performed shall be guaranteed for a minimum period of one (1) year against defects in material and workmanship. At any time during the period, if a defect should occur in any item, that item shall be repaired or replaced by the seller at no obligation to the Buyer, except where it be shown that the defect was caused by misuse and not by faulty manufacture. The Bidder expressly warrants all items to be new, free from defects in design, materials and workmanship, and to be fit and sufficient for their intended purpose. The Proposer shall provide express warranties for all equipment proposed. These express warranties shall be full warranties for all parts, labor, and shipping costs required to repair and maintain the equipment for the duration specified in this section.

The Vendor shall bear the return shipping of equipment which becomes inoperative during the warranty period or which does not meet the specification of the City of Mesa.

1.10.1 *Warranties General*

All manufacturer's warranties or guarantees on electronic, electrical and mechanical equipment, materials, technical data, and products purchased for use on the project which are consistent with those provided as customary trade practice, shall be obtained by the Supplier. The Supplier and the manufacturer shall each be jointly and severally liable for the warranty.

Upon acceptance of the project, the Supplier shall assign to the City, all manufacturer's warranties or guarantees on all such electronic, electrical and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Nothing contained in these Specifications shall relieve the Supplier of the implied warranty that the equipment, system, and services provided are both fit and merchantable for the uses intended as indicated herein.

Technical data, as used in this section, means any recorded information such as software, programming manuals, system documentation, etc. regardless of form or characteristics of a scientific or technical nature. The Supplier shall warrant that all technical data delivered under this contract is correct and complete and that if any revisions are required in the technical data due to errors, deficiencies, or omissions, the Supplier shall deliver the revisions to the City. This requirement continues throughout the life of the system.

1.10.2 *Five Year ATMS Software Warranty*

The Supplier shall provide a software warranty for the signal system for a period not less than five years after project acceptance at no cost to the City of Mesa. Any software revisions to the signal system software correcting bugs or deficiencies in the software shall be provided in a timely manner to enhance the operation of the ATMS.

Software enhancements or any new features added to the signal system software by the Supplier or manufacturer shall be offered to the City of Mesa at no cost. Software enhancements may result from new system development or problem resolutions completed for other agencies. These upgrades shall be utilized at the City's discretion.

No revisions to the source code will be made by the City or outside forces without first consulting the Supplier. The City recognizes that the Supplier cannot maintain source code which has been modified by an outside party unless Supplier is notified and approves of all software revisions. Therefore, the Proposer shall indicate whether a 5 year warranty can be provided under these terms. The intent is that the City and the Supplier receive mutual benefits from any signal system software enhancements performed by either party.

The City will supply any labor necessary to update the controller or signal system software using updates received from the Supplier.

1.10.3 *Warranty Period*

All equipment and software warranties shall commence on the date of Final Acceptance of this project.

As a minimum the following equipment and software full warranty periods shall be required:

- 1) Leased Line Data Modem - 2 years
- 2) System Software - 5 years
- 3) Computer Equipment Provided by the Supplier - 2 years

1.10.4 *Extended Express Warranties*

It is desirable that the City of Mesa obtain the best full warranty possible covering all parts and labor necessary to keep the equipment proposed in good operating condition for the maximum time periods.

Therefore, the Proposer is invited to offer extended express warranties for the equipment proposed which exceed the minimum time periods.

1.11 CONTRACTOR LICENSE REQUIREMENT

The Contractor shall procure all permits and licenses, and pay all charges and fees necessary and incidental to the lawful conduct of business. The Contractor must stay fully informed of existing and future Federal, State and Local laws, ordinances and regulations which in any manner affect the fulfillment of this contract and shall comply with the same. Where applicable, this shall include familiarity and compliance with local building, plumbing, electrical, and fire codes.

The Contractor shall insure that all employees have a legal right to live and work in the United States. Upon request, a copy of the birth certificate, Certificate of Naturalization, Immigration Card, or Special Entry Permit shall be given to the City's Contract Administrator. In addition, employee compensation shall meet all applicable requirements of the Fair Labor Standards Act and Federal minimum wage laws.

The Contractor shall also comply with all applicable OSHA regulations, and in particular those set forth in Title 29 of the Federal code of Regulations, Section 1910, 1200 "Hazard Communication." The contractor bears full responsibility for employee training, safety, and providing necessary equipment to achieve compliance prior to the contract commencement date. Upon request, Contractor shall demonstrate to the City's satisfaction any programs, procedures and other activities used to insure compliance.

1.12 HOLD HARMLESS AGREEMENT & INSURANCE REQUIREMENT

The Contractor agrees to defend, indemnify and hold harmless the City, its officers, employees and agents against all losses, claims, actions, judgments and all liability for injury to persons, including wrongful death, damage to property or both occurring during or in consequence of the performance of this contract where such injury or damage is related to any defect in the goods and materials and/or services delivered or to the action or negligence of the Contractor, his employees, subcontractors or agents.

The Contractor warrants that all goods or materials to be supplied shall be delivered free of the rightful claims by any third party of patent infringement or the like. The Contractor also agrees to defend, indemnify, and hold harmless the City, its officers, employees and agents from any and all license, royalty and proprietary fees and costs, including legal costs, which may arise out of the use of any goods or materials purchased as a result of this solicitation. The Contractor further agrees to pay and discharge any and all judgements or decrees which may be rendered in any such suit, action or proceedings against the buyer.

The Contractor shall maintain at all times during the term of this Contract, coverage in the minimum amount of \$1 million per occurrence for commercial general liability, including contractual liability as indicated on the enclosed sample form. In addition, for vehicles owned and operated by the contractor and its employees, automobile liability coverage of at least \$1 million combined single limit is required.

For all coverages, the City of Mesa, their agents, officials, or employees shall be named as additional insured. Prior to the execution of the Contract, the Contractor shall provide the City with a Certificate of Insurance, and the City reserves the right to request copies of any or all of the above policies, endorsements, or notices relating thereto. This will include Workers compensation insurance in the Statutory amount and employers liability as outlined on the sample form, where applicable. All insurance certificates are subject to review and approval by the City's Risk Management Attorney.

When the City requires a Certificate of Insurance to be furnished, the Contractor's insurance shall be primary of all other sources available. When the City is a certificate holder, the Contractor agrees that no policy shall expire, be canceled or materially changed to affect the coverage available without thirty (30) days advance written notice to the City.

1.13 BOND REQUIREMENTS

The Contractor shall furnish to the City a Payment Bond of \$100,000.00 solely for the protection of claimants supplying labor or materials to the successful bidder or its subcontractors in the prosecution of the work provided for in the contract.

The successful Vendor, simultaneously with the execution of the Contract, will be required to furnish a Performance Bond in the amount of \$100,000.00 issued by a firm licensed and registered to transact such business within the State of Arizona.

1.14 AWARD CRITERIA

The City will accept the proposal(s) which appear to be in its best interest, and matters other than price will be considered in determining the award.

The City reserves the right to accept or reject any or all proposals or parts thereto, to waive any informalities in any proposal and to reject the proposal of any individual or firm who has been delinquent or unfaithful to any contract with the City.

All proposals will be evaluated based on the factors discussed in this specification.

1.15 PROPOSAL AND SUBMISSION REQUIREMENTS

For ease of handling and reference, submit the proposal on 8-1/2" x 11" paper in a ring binder or other binding. Each page shall be numbered, including technical or marketing materials submitted with the proposal.

The proposal package must include the following.

- 1.15.1 *Title Page* - Show the RFP number and subject, firm name, address, telefax and telephone numbers, name of contact person, and date.
- 1.15.2 *Table of Contents* - Clearly identify the material by section and page number.
- 1.15.3 *Letter of Transmittal* - Briefly describe your firm's understanding of the services to be performed and make a positive commitment to provide the services as specified.

Give the name(s) of the person(s) who are authorized to make representation for your firm, their titles, address, and telephone/telefax numbers.

The letter must be signed by a corporate officer or other individual who has the authority to bind the firm.
- 1.15.4 *Firm Qualifications and Experience* - Provide specific qualifications and experience on projects of a similar size and nature.

Provide at least three (3) references for which your firm has provided the same or similar services. Include a point of contact, telephone number, and a brief description of the services provided.
- 1.15.5 *Project Manager* - Identify the Project Manager, including specific qualifications and experience related to the management and development of projects similar to the scope detailed in the RFP. Include project reference contact names and telephones numbers.
- 1.15.6 *Financial Resources* - Provide financial statements, preferably audited, for the most recent three (3) years.
- 1.15.7 *Contractor Accessibility* - Describe the firm's location from which the preliminary services are to be provided and the ability to meet in person with City personnel as required during the performance of the contract.
- 1.15.8 *Project Methodology and Approach* - Substantiate your understanding of the project, giving your methodology and approach for completing the required project goals in a timely, accurate and efficient

manner. This discussion should be detailed enough to serve as an initial scope of services for the project. Estimate the personnel hours for your proposed staffing to accomplish this project.

1.15.9 *Sample Contract* - The Vendor shall submit a sample contract with the proposal. The contract for the System shall offer all items requested by this proposal. The City will review this contract and use it as a basis for determining the criteria for a Best and Final Offer. The contract will be binding when signed after the award of the proposal.

1.15.10 *System Functional Description* - A brief description of the proposed system shall be provided so the evaluation and selection committee can gain a basic understanding of the overall capabilities of the system. System capabilities, strengths, and weaknesses shall be clearly noted. A description of the proposed system architecture shall be included.

The Vendor shall indicate all computer hardware and software for the system with a brief explanation of each. This information shall complement the sample software and equipment if provided with the proposal.

Each Vendor shall provide a typed detailed response to these specifications arranged in sequential specification section order with the name of the Vendor and date provided at the top of each page.

1.15.11 *Technical Environment* - The technical environment that is required to install and operate the proposed system must be indicated.

1.15.12 *Official Price Sheet* - Each Vendor shall specify the total cost of the proposed system using the Official Price Sheet provided with this Request for Proposal.

A complete description of the proposed equipment and material to be used on the project must be provided. The list shall include the proposal item number, name, manufacturer, model or part number and "catalog cut sheets" or other descriptions of each unit of equipment. The "catalog cut sheets" and descriptions shall be of sufficient detail to demonstrate that the Vendor understands the equipment requirements. This submittal shall not be construed to be the lists of the detailed equipment and shop drawings specified elsewhere.

All costs included in the proposal must be shown on the Official Price Sheet. These costs shall include, but are not limited to, freight, transportation, unpacking, installation of the signal system software, insurance, testing, clean-up, and other costs. No charges not identified in the proposal may be billed to the City.

1.16 DISCUSSIONS

After selection of qualified Vendors, the City may enter into discussions concerning the proposed systems.

These discussions will be on an individual basis and closed to third parties and other Vendors. The primary purpose of these discussions will be to reach a mutual agreement concerning the terms, conditions, and scheduling of the project. During the discussions, the City and Vendor will develop a proposed contract.

The City and the Vendor will review in detail all aspects of the City's requirements and the proposal. During this review, the Vendor may offer and the City may accept revisions in the proposal. The intent of these revisions is to adjust the requirements of the system features identified in the specifications. Subsequent responses from the Vendor shall clearly identify omissions and additions from previous versions. The Vendor shall be responsible for the prices submitted on page one of the Official Price Sheet, and these prices shall reflect the Vendor's ability to meet minimum system and controller requirements within the time requirements defined by this specification.

Vendors will be given fair and equal treatment with respect to any opportunity for discussion.

A complete project schedule will be developed by the City and the Vendor during the discussions. This project schedule shall provide installation and testing milestones throughout the contract period.

The purpose of this project schedule is to define a completion schedule which is acceptable to the Vendor and the City of Mesa. This project schedule will be used by the City to assess liquidated damages arising from late delivery of items agreed upon in the project schedule.

The Vendor shall summarize this schedule and provide the City with seven (7) copies of the specification compliance targets and construction scheduling for the entire project (CPM, PERT or equivalent). This schedule shall clearly indicate the interrelation of individual tasks and shall be divided into logical stages with equipment design, design approval and factory demonstration tests, delivery of equipment, installation dates, and completion dates of work items clearly indicated.

All items to be provided by the City shall be included in the schedule to assure that they will be delivered in time so as to not delay the Contractor.

Sufficient detail shall be shown to permit monitoring project progress in monthly intervals. The Contractor shall provide an updated project schedule monthly showing both planned and actual work progress.

Upon approval by the City, the project schedule and sequence of work shall constitute the construction procedure for this project. No change will be permitted in the approved sequence except as approved by the Signal Systems Supervisor in writing.

1.17 BEST AND FINAL OFFERS

The Best and Final Offer must contain a proposed contract discussed with the City. In addition, the Vendor must provide a written guarantee that there will be no additional costs to the City for equipment, materials, and labor necessary to meet the intent of this specification and contract documents.

1.18 SHOP DRAWINGS AND USER, TECHNICAL, MAINTENANCE MANUALS

The Contractor shall provide five (5) copies of user, technical and maintenance manuals for each type of electronic apparatus proposed for this project upon delivery of this equipment. The function, and capability of each deliverable item shall be described. These manuals shall be standard printed material from the manufacturer, reproduced copies of the manufacturer's manuals are not acceptable.

Shop drawings shall be submitted within fifteen (15) calendar days after execution of the contract. The drawings shall include, as a minimum, a layout of all terminals and devices in relation to the Central Control Facility, the complete Communications layout including line configuration and field terminations, and a schematic of the network configuration. Shop drawings shall be submitted in CAD (AutoCAD*.dwg or .dxf) or accepted format as well as in printed format.

During the contract, the Contractor shall modify the shop drawings to reflect changes in the system or layout of the system. Two (2) copies of the final shop drawings shall be submitted to the City for review and approval immediately prior to completion of the project. The City will provide a response to these submittals within fifteen calendar (15) days. The Contractor shall resubmit for review and approval as many times as are necessary to obtain the City's approval. Approval does not relieve the Contractor of his responsibility to meet the requirements of the specifications.

Upon final approval, five (5) complete sets of all shop drawings shall be provided to the City.

1.19 LIQUIDATED DAMAGES

For each and every calendar day that work shall remain uncompleted after the time specified for the completion of the work in the proposal, or as adjusted by the City, the sum per calendar day shown below, unless otherwise specified in the proposal, may be deducted from monies due to or to become due to the Contractor, not as a forfeit or penalty but as liquidated damages. This sum is fixed and agreed upon between the parties because the actual loss to the City and to the public caused by delay in completion will be impractical and extremely difficult to ascertain and determine.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time fixed for its completion may have been extended, will in no way operate as a waiver on the part of the City of any of its rights under the contact.

LIQUIDATED DAMAGES			
Original Contract Amount		Daily Charges	
From More Than	To and Including	Calendar Day or Fixed Date	
\$0	\$100,000	\$750	
\$100,000	-	\$1,250	

1.20 INSPECTION AND TESTS

The City of Mesa retains the right to rigidly inspect all structures, equipment, and materials used in the project before, during, and after installation.

The City also reserves the right to inspect the work during fabrication to determine if the plans and specifications are in compliance with this document.

Such inspections and tests shall not release the manufacturer from strict compliance with specifications when the work is completed and offered for acceptance.

2 EVALUATION AND SELECTION PROCESS

2.1 EVALUATION AND SELECTION COMMITTEE

The City of Mesa will conduct a comprehensive and impartial evaluation of all proposals received for an ATMS System. Each proposal received will first be analyzed to determine completeness and responsiveness to the request for competitive sealed proposal as defined in this specification.

An evaluation and selection committee will be established to evaluate the proposals and select a qualified Supplier. This committee will be comprised of systems and operations staff. It will determine the responsiveness and acceptability of each proposal, evaluate each proposal in the functional, technical and support areas and develop an overall ranking according to the criteria described below.

2.2 EVALUATION CRITERIA

Each proposal will be evaluated in the following areas with respect to the requirements as outlined in this document:

- 20% Compliance With Specifications
- 25% Total Proposed System Cost Evaluation
- 30% Required Minimum System and Controller Performance
- 20% ATMS Options
- 5% Proposer Reliability and Support

2.2.1 *Compliance with Specifications*

Compliance will be evaluated using all sections from this specification.

2.2.2 *Total Proposed System Cost Evaluation*

A cost evaluation will be based on the variance of the total proposed system cost with the other proposals. This total proposed system cost shall include any alternate costs identified in the detailed specification response and listed on the Official Price Sheet.

A cost rating (in percent) shall be calculated as follows:

Proposal Cost - Low Proposal Cost	= Difference
1 - (Difference/Low Proposal Cost)	= Rate of Difference
(Rate of Difference) x (Max Points)	= Points Awarded

2.2.3 *Required Minimum System and Controller Performance*

The proposed signal system and controller will be carefully evaluated using this specification. The description of the equipment and software operation will be evaluated as individual components and as a total system.

The Proposer shall propose hardware and software to meet the minimum system and controller requirements defined by this specification. However, unless this hardware and software are available for evaluation, the proposal will be considered to have more risk than hardware and software which is complete during the evaluation process.

It is recognized that a particular proposal may not include all of the desired capabilities. Therefore, Proposers must provide an accurate, detailed description of the capabilities of the proposed system and clearly indicate the manner in which a particular function could be added to the current system to satisfy desirable performance and include the costs of such additions/modifications in the proposal cost summary.

The evaluation and selection committee will carefully analyze packages for:

- the functionality of the controller integration with system functions
- the functionality of the leased line modems
- the functionality of the NEMA TS 2 equipment
- the functionality of the signal system software
- the ease of operation from the system operator's perspective
- the ease of operation from the field technician's perspective
- report generation and query capabilities
- structure and sequence of events

2.2.4 *ATMS Options*

The proposal will be evaluated for the Proposer's response to ATMS Options.

Proposers may state or recommend solutions to achieve the objectives and identify the costs required for each alternate on the Official Price Sheet - ATMS Options..

Proposers must indicate their willingness and level of support for implementing these enhancements. The evaluation of system options will be based on cost, feasibility of the alternates proposed, and potential improvement features.

2.2.5 *Proposer Reliability and Support*

The Proposer's overall reputation and ability to support the installation initially and on an on-going basis will be evaluated. The Proposer's experience in implementing similar systems for other agencies will also be evaluated.

3 REQUIRED MINIMUM SYSTEM AND CONTROLLER PERFORMANCE

The overall goal of this project is to implement an Advanced Traffic Management System that shall operate essentially unattended to monitor and select timing plans for all traffic signals within the system. This system shall utilize a PC based centralized distributed architecture to facilitate traffic control operations. This new system shall enhance the City's ability to optimize traffic signal timings and reduce driver delay, fuel consumption, and air pollution while minimizing the City's maintenance and operating costs. Any system not meeting the following minimum objectives may be disqualified from the proposal or the Proposer may be required to submit an addendum insuring that these minimum objectives will be met.

3.1 ATMS PERFORMANCE

The following objectives outlined below define required minimum system performance used to rate Compliance with Specifications.

1) System Related Features:

- Function & fully operate with Econolite TS-2 Controllers (*Use as a minimum the features identified by NTCIP.*)
- Receive stored detector data from the controller
- Support time and date formats for leap year, daylight savings (enable/disable), and century compliant
- Provide real time & historical reports on events, communication statistics, detectors, commanded routines
- Security provided by dual passwords (name/password) and privilege levels, with one person ultimate authority. Password shall be case sensitive. User shall be able to change their own password
- Extensive context sensitive help information on-line to assist users
- Traffic responsive operation using plan selection
- Traffic responsive time of day, day of year automatic plan selection and operation
- While operating in traffic responsive mode intersections are assignable to sections on a time of day basis

2) Communications:

- Communicates in real time to all intersections
- Communication support for baud rates up to 115,200 bits per second
- Supports 512 intersections on serial ports
- Communicates directly with compatible controllers
- Communicates indirectly to malfunction management unit, and detectors through controllers
- *Support NTCIP for communication to TS-2 controllers*
- Support for virtually every communication medium

3) Database:

- SQL compatible database
- Ensure the integrity of system data and timing plans
- Database downloading and uploading on a system, line, section or intersection basis
- Automatic intersection database verification

4) Graphics

- GIS product support (ArcView)
- Graphics: real time area, section, or intersection data drawn and selected by the user; shall be capable of importing Autocad, Corel, Paintbrush, Digitized Images, etc.
- Support real time video on the same PC used for traffic operations

3.1.1 *Ease of Operation*

The operation of the system shall be intuitive, menu-driven, and free of all computer bugs and software problems which hamper the normal operation of the system.

The use of “quick-key” combinations shall complement the menu structure.

3.1.2 *Support Multiple Networked and Remote Work Stations*

The system shall support multiple networked and remote work stations for the exchange of all authorized information among users.

The system shall allow dial up access. The intent of this objective is to allow the system to be operated and monitored, not just from the central office, but also from remote sites. Direct access shall be provided using three (3) dial up modems. These modems shall automatically sense incoming baud rates and be capable of performing at baud rates from 1200 to 57.6K. Passwords shall be programmable and shall limit access to "sensitive" data in the system and on the network. The method of accessing the signal system remotely must be described in the proposal.

3.1.3 *System Monitoring*

The proposed system shall provide a means of monitoring the operational status of all intersections within the system. The signal system shall be capable of monitoring a single intersection on a second-by-second basis while polling all other intersections in the system. The system shall allow a minimum of sixteen (16) simultaneous user tasks (one per terminal) without degradation in performance.

The software shall provide a means of displaying all conditions at intersections when using either color or monochrome monitors. Reverse imaging, underlining or other City approved methods will be acceptable.

The proposal shall identify all the data provided from the local intersection controllers to the system computer:

3.1.4 *Intersection Status Displays*

The following minimum status displays shall be represented in a second by second real time basis from the local intersection controller:

- 1) Phase(s) in service (one per ring) up to 16 phases
- 2) Phase(s) next to be serviced (one per ring)
- 3) Overlap(s) in service
- 4) Presence of vehicle call (one per phase)
- 5) Presence of pedestrian call (one per phase)
- 6) Presence of bicycle call (one per phase)
- 7) Reason for green termination (one per ring)

- a) Gap-out
- b) Maximum time-out
- c) Force-off
- 8) Pedestrian service (one per phase)
- 9) Max I & Max II (one per ring)
- 10) Walk I & Walk II (one per ring)
- 11) Rail, Fire, Emergency Vehicle, and User Definable preemption calls
- 12) Cabinet door status
- 13) Police, Conflict, and Technician Flash
- 14) User Definable Alarms
- 15) Mode of Operation
- 16) Power outage
- 17) Current cycle, split, and offset
- 18) Coordination status (coordinated or free)
- 19) Local background cycle timer
- 20) System background cycle timer
- 21) Last cycle and splits timed

Steady and flashing indications may be used for phase in service, phase next, and pedestrian service (walk, don't walk), or any mutually exclusive indications.

3.1.5 *Overlap Timers*

Independent interval timers for each overlap shall operate during an overlap independently from any other phase timer.

3.1.6 *Phasing and Left-turn Mode Variable by Time of Day, Special Event, or Manual Control*

System shall be capable of various operating modes such as lead/lag left turns, turning on and off protected/permissive left turn phases, changing phasing sequence for emergency conditions, and varying detector options (first to third car actuation.). These varying modes shall be activated by time-of day, special event, manual control, or route preempt. These changes in operation can be achieved through special functions.

3.1.7 *System Time Reference Synchronization*

The system shall synchronize the time base in all intersections either one intersection at a time or on a system-wide basis.

The system software shall upon user specified parameters download the universal time and date to the local controllers which shall begin a timing transition on the cycle following the download if the offset for the current timing plan is more than one second off the true offset.

The system shall provide some facility for automatically updating the universal time reference in all local controllers at a specified time-of-day without operator intervention.

To accommodate varying systems' zero reference points the time reference point shall be user adjustable. System software shall be provided to check the local controller times and report deviations from the universal time standard.

3.1.8 *Software Support*

The Supplier is required to supply all assemblers, compilers, and development software used to produce the supplied version of the signal system software or propose an alternate method which insures the City can modify or add additional software enhancements using in-house personnel, should the supplier no longer be capable of such support.

The Proposal shall define type of software (source code, libraries, and/or DLL-Dynamic Link Libraries, etc.) provided which will allow the City to add software enhancements to the system.

3.1.9 *Communications*

The Communications system equipment, material and services furnished by the Supplier shall provide as a minimum, the functions and features described herein. The Supplier shall assume full responsibility for proper operation and interfacing of the communications system for the two-way transmission of control commands and equipment monitor data between the ATMS and field located traffic signal controller equipment.

The communications system shall make use of the leased and City owned telephone lines for transmissions and the city owned cable extensions (multi-points) between the ATMS and intersections. Although not initially part of the existing system, the ATMS shall also be designed to function through various forms of communications media, such as coaxial cable, wireless devices, fiber optics, etc.

The following error detection criteria shall apply when the system is fully loaded:

- 1) The probability of an undetected error shall be no more than 1×10^{-8}
- 2) The probability that the communications hardware will reject a valid command or monitor word shall be less than 1×10^{-6}
- 3) The valid word throughput shall be at least 99.95 percent of the words transmitted for both command and monitor

The communications protocol used for upload, download, monitoring and logging communications to the controllers shall be supplied to the City.

The City shall be provided with all applicable licensing for the communications protocol used for the ATMS. This licensing shall include the right to develop software utilizing the communications protocol.

The protocol documentation shall include all ROM and EEPROM addressing and memory maps appropriate for the transmission of uploading, downloading, monitoring and error logging information.

The system shall be required to service 512 intersections with a minimum of 4,000 system or counting detectors without any degradation in system performance. In addition, the system shall have the ability to redistribute communications to additional communications servers, to allow for future expansion of the system.

3.1.10 *Upload/Download Capability*

The proposed system shall provide a means of uploading and downloading all signal timing parameters between the system computer and the intersections. The system software shall upload and/or download data including but not limited to the following:

- 1) Intersection timing parameters - Call Not Actuated (CNA), Ped Recall, Non-Lock, Min Recall, Coordinated, FREE, etc.
- 2) Detector data from a minimum of 32 detectors per intersection
- 3) Alarm data - NEMA TS-2 Controller
- 4) Event data
- 5) Mode selection
- 6) Current universal time and date downloaded to the intersection

- 7) Current controller time and date uploaded to the system

3.1.11 *Signal System Database Features*

The system software shall provide a means of building and maintaining a complete database of all intersection timings and configurations, a history of events and alarms, detector data history, and a record of other performance data and pattern selection. It shall be possible to copy from one intersection to another intersection all present system data as well as NEMA TS-2 Controller selected timing data sets (cycle length, phasing, split times and offsets) from one specified timing plan to another specified timing plan in the controller database.

The system software shall provide a means of generating user-defined reports (SQL) compiled in the database. The system software shall provide a user-friendly, menu-driven means of entering and maintaining the system database.

The schedule function is defined as a time-of-day event which executes a specified software routine for a specified date or day-of-week. The system operator shall be able to specify the schedule function for a single intersection or group of intersections by a list of intersection address numbers applied to the event. The schedule function allows the operator to program an event for a single intersection or group of intersections which executes at the specified time-of-day without operator intervention.

Holiday schedule programs shall be individual to each intersection.

When a special event is programmed in the database, the user shall have the option of having the event deleted after execution.

Database integrity of field devices is assured by built in checksums and automated database comparison techniques. The system shall log to a file and notify user specified workstations of differences with a pop-up action box. Notification shall include the specific location within the database where the difference(s) occurred.

The signal system software shall log output from the database integrity check to assist system operators. A schedule function providing unattended execution of the feature shall be provided.

Once an intersection database is created, the system shall maintain it in the format applicable to the type of equipment it was created for (e.g., *NTCIP, enhanced NTCIP, etc.*). When the type of field equipment is changed, it will require an additional database to be created. The system shall maintain both the old and new databases in separate tables. Changes to one intersection's equipment database shall not be copied to the other database(s). Therefore, each database, after initial creation, shall be readily available to allow for installation of any type of system supported control equipment which might be placed at an intersection.

The system shall be capable of displaying a list of the yearly programs sorted by date, providing the date, day of month and day plan number programmed for each date. The default for this display shall be the current date; however, the operator may input a desired date for display and have the ability to scroll the display to increment and decrement the yearly program display.

The system shall provide a display of a specified day plan sorted by time, listing all the time-of-day parameters.

3.1.12 *System Status Displays*

The system software shall provide a means of creating a variety of intersection graphics from a library of sample intersections and/or on the basis of specific intersection geometries. The system shall be able to utilize digital/digitized photographs/images for intersection graphics.

The system shall import map data from most GIS packages for area-wide display and intersection display. Pan and zoom operations shall be functional within the area-wide display.

System shall provide:

- a) Dynamic displays of selected areas at a once per second communications rate with the following
 - 1) Intersection status: on-line, off-line, failed, preemption
 - 2) Detector volume and occupancy thresholds (graphic and numeric)
 - 3) Incident detection based on volume + occupancy
- b) Dynamic displays of individual intersections with the following
 - 1) Intersection status - on-line, off-line, failed
 - 2) Individual detector data and status by specified failure mode
 - 3) Signal displays - vehicular and pedestrian displays
 - 4) Controller timing data
 - 5) Average vehicle arrival distribution

3.2 ATMS OPTIONS

- 3.2.1 Remote request for complete data download
- 3.2.2 Incorporation of police flash logging by the central software
- 3.2.3 Window templates to automatically load a user defined group of windows onto the screen based on intersection or section
- 3.2.4 Intersection long-term monitoring to a central computer disk file with replay/fast forward capability
- 3.2.5 On-screen graphic link data - to display dynamic road segments speed and travel time values
- 3.2.6 Weather monitor for operation of special functions and auxiliary devices
- 3.2.7 Variable message sign control to enter message database, editing and preview screens
- 3.2.8 Controller database conversion to automatically convert a controller database to another manufacturer's controller
- 3.2.9 System database enhancements to add controller manufacturer enhancements.
- 3.2.10 Additional communication server
- 3.2.11 Hardware and software to utilize a video wall
- 3.2.12 Operator commands issued to individual or groups of local controllers have a time-out period which provides a measure of communication fault tolerance. The command shall not be lost and shall remain in effect in the event of loss of power, pre-emptions, etc.
- 3.2.13 Paging for the Server
- 3.2.14 Virus Protection for the Network
- 3.2.15 Automated database comparison to field intersection database.
- 3.2.16 Integrated traffic optimization software
- 3.2.17 "Heads-up alarm" display

4 HARDWARE AND SOFTWARE PROVIDED BY THE SUPPLIER

The following specification describes the minimum signal system computer hardware and software supplied by the Supplier. The Supplier will be responsible for integrating this signal system with the computer hardware and software provided by the City.

4.1 SIGNAL SYSTEM COMPUTERS

All computer equipment used by the City of Mesa shall be IBM-compatible PCs that are connected to a Novell network by 100MB Ethernet connections.

4.1.1 *Common Server Equipment*

All system servers shall meet the following minimum requirements:

- Pentium Pro processor, 200 MHZ or greater housed in a Tower Case
- 512K L2 cache
- 128 megabytes random access memory
- 8 gigabyte hard disk drives
- SVGA Monitor (.28 dot pitch) 1280 X 1024 resolution
- SVGA Video Card with 2 megabytes RAM
- CD-ROM Drive 20x speed
- Keyboard and Mouse Pointing Device
- 1.44 megabyte 3.5" floppy drive
- 1 parallel port (bi-directional EPP)
- Ethernet network connection 100 megabit/second
- Un-interruptible power supply (with serial interface to computer that causes orderly shutdown in the event of the loss of AC power)

All hard drives for the server equipment shall be the same brand and model. All hard drives shall be mounted in an assembly which allows removal of the drive(s) without the use of tools.

One spare hard drive and interchangeable hard drive mounting assembly shall be provided.

4.1.2 *ATMS File Server*

The ATMS file server computer shall hold resident all Advanced Traffic Management System (ATMS) software, the system database, signal timing programs, and selected commercial software. The file server hard drives shall be fault tolerant so the system can continue to function in the event of a hard drive failure.

The following equipment shall be added to the common server list as a minimum for this unit:

- CD-Writer (Minimum 2x write, 6x read), CD-R, and CD-Re-recordable capable
- Tape backup system (10 GB/tape minimum - system/network applications)
- 2 serial ports (high speed 16550 UART)

4.1.3 *Communications Servers*

This device shall handle the task of field communications via "digi-board" serial ports or approved equal to a minimum of 512 intersections. The communication server's hard drives shall be fault tolerant so that the communication server can continue to function in the event of a hard drive failure. Additionally, the fault tolerance of the communication servers shall allow the ATMS to continue to function in the event of a partial failure.

All communication servers shall meet the following minimum requirements:

- Pentium II processor, 333 MHZ or greater

4.1.4 *Supplemental Requirements*

The Supplier shall provide three (3) 57.6K dial-up modems. These modems shall link remote work stations to the ATMS using standard dial-up telephone lines.

4.2 CENTRAL COMMUNICATIONS EQUIPMENT

The Central Communication Equipment should consist of three (3) Modem Racks, one (1) Power Supply, fifty (50) Communications Modems, Central Communication Cabinet(s), Equipment Interconnect Cables, Diagnostic Tools and Spare Equipment, all of which are to be supplied under terms of this contract.

4.2.1 *Electrical Characteristics*

Central communication modems shall meet or exceed NEMA TS2 standards for protection from voltage transient, surge protection, and equipment failure, etc.

4.2.2 *Central Communications Assembly*

1) Modem Rack

- 16 modem slots per each 19" modular rack
- Rack shall be 7" high x 19" wide x 15" deep with two mounting holes per side.
- The back panel of each rack shall provide a female DB-25 RS-232 interface and a 4 position single row terminal block audio interface to each of the 16 modems.
- Keyed to prevent inadvertent upside down installation.
- Edge connectors used are Cinch #50-44SN-9

2) Power Supply

- With test jacks and L.E.D. for checking the status
- The +12VDC and -12VDC supplies shall be individually fused.
- The dimensions shall be 14" high x 19" wide x 6" deep with two mounting holes per side.
- Capable of operating with a maximum load of 96 modems and provides 200 Watts of continuous power.

3) Modem

- Front mounted indicators shall include XMT, RCV, RTS, CTS, and CAR status
- Switch selectable anti-streaming feature
- Switch selectable to operate with 1200 baud 2 wire half duplex or 1200 baud 4 wire full duplex communications
- Shall meet model 400 anti-streaming modem power consumption specifications
- Current and voltage compatible transformers shall operate with existing phone lines. 50 VDC & 20 mA.
- Decibel adjustable levels from 0dbm to -8dbm
- Timing switchable parameters for:
 - RTS - CTS
 - Carrier Delay
 - Soft Carrier Turn Off

Receiver Squelch

4.2.3 *Central Communications Cabinets*

The cabinets shall be equipped with standard 19" mounting rails for rack or shelf mounting of all central modems and power supply equipment. Each cabinet shall be furnished complete with front and rear doors, AC power distribution panels, exhaust fans, casters, leveling feet, cable supports and stabilizer bars and shall be fabricated from metal. These cabinets will be located in the Traffic Management Center.

4.2.4 *Equipment Interconnect Cables*

All cabling, with connectors, shall be provided to interconnect all central communications equipment provided by the Supplier. All connections between equipment shall be made by plug in connectors.

4.2.5 *Diagnostic Tool*

One (1) modem extender card and diagnostic software shall be provided for communication tests.

4.2.6 *Spare Equipment*

Two (2) spare, communication interface cables, which connect the modem rack and the U.S. West communications panel, shall be furnished. Two (2) spare, serial interface cables, which connect the modem rack to the digi boards, shall be furnished.

4.3 NOVELL COMPUTER NETWORK AND EQUIPMENT LAYOUT

The Supplier shall provide the latest release as of contract execution of Novell Netware for the signal system computers. The Supplier shall add the network with the Novell Netware during Operational Test, as identified in these specifications. All cables and wiring required between the various items of equipment at the central control facility will be provided by the Supplier.

4.4 UNIVERSAL TIME REFERENCE FOR THE SIGNAL SYSTEM COMPUTER

The Supplier shall provide a method which will automatically maintain the operating system time-base in the signal system computer using a national time standard. A WWV device connected to the signal system computer may be used.

The Supplier shall also be responsible for installing a device and insuring that the time standard is updated to the satisfaction of the City of Mesa.

4.5 SOFTWARE - ASSEMBLERS, COMPILERS, DEVELOPMENT SOFTWARE

The latest version of the operating system platform shall be provided for each signal system work station (fifteen copies). All copies are to be supplied with complete documentation.

The Supplier shall provide a licensed copy with documentation of each software product used to develop the ATMS (i.e. assemblers, compilers and/or development software). Proprietary source code for the signal system software must also be provided.

The assemblers, compilers, development software, and compiled binaries used for the local intersection equipment (controller, conflict monitor, detector cards) shall not be included in this requirement.

4.6 DOCUMENTATION REQUIREMENTS

The Operator’s Manual shall present detailed procedures for equipment setup, program loading, operation procedures, operational options, program monitoring, recovery procedures, and preparing and updating the data base.

The Computer and Operating Manual shall describe the system structure and organization.

All service manuals shall include the following:

- Theory of operation
- Programming instructions
- Schematic diagram
- Module position and identification
- Front panel functions and controls
- Display indications
- Picture of major components
- Maintenance instructions
- Troubleshooting instructions
- Complete parts listing with Vendors’ names for parts not identified by universal part numbers

The following table details the number of manuals that shall be provided with the ATMS.

<u>Item</u>	<u>Number Required</u>
ATMS Operator Manuals	20
Computer and Operating Manuals	1 per computer supplied
Auxiliary Software Manuals	1 per computer supplied or 1 per licensed user, whichever is greater
Training Manuals	20
Central Modem Manuals	1 per 16 modems supplied

4.7 DOCUMENTATION ACCEPTANCE

The documentation shall be continually revised to reflect changes in the software through the entire project. Final documentation shall be submitted for review and approval immediately prior to the completion of the project.

4.8 SOURCE CODE AND DUPLICATION OF SOFTWARE BY THE CITY OF MESA

The City shall be authorized to reproduce all system software for its own use at no additional cost. In addition, the City shall be authorized to duplicate all system and controller software developed by the Supplier and stored in EEPROM, flash-PROM, or other permanent storage devices without any royalties, fees, or other financial obligation.

Before final system acceptance, the Supplier shall provide the City with the current source code for the ATMS.

4.9 NO ADDITIONAL COMPENSATION FOR HARDWARE AND SOFTWARE

All costs for hardware and software necessary for a fully functional ATMS not listed on the Official Price List shall be considered a Supplier's expense.

- 4.9.1 Such costs may include but are not limited to wiring terminals, cables, cards, connectors, etc., necessary for the ATMS to function fully. This includes auxiliary devices such as bridges and routers to accommodate a fiber optics cable between the Central Control Facility and the West Signal Shop.
- 4.9.2 No additional compensation will be given for hardware and software provided for the ATMS unless these costs are identified as alternate prices on the Official Price Sheet and the Supplier fully describes these items on the detailed response to specification as required and the City elects to include these prices in the Best and Final Offer.

4.10 TRAINING

This specification describes the training to be provided on the installation, operation, and maintenance of the distributed signal system.

- All training shall be conducted in Mesa, Arizona at facilities provided by the City.
- This training service shall be provided at no additional cost to the City including but not limited to costs for travel, lodging, meals, telephone charges, or staff time required by the Supplier.
- All instructors shall be fully qualified and well-versed in the operation of the individual components and the overall system. Supplier shall provide his own computer to overhead projector display adapter for portions of the training involving the use of a computer.
- The duration of each training block shall be no less than four hours. All training shall be scheduled during normal working hours.
- The training dates shall be scheduled no less than two weeks in advance, and are subject to the City's approval.
- The City may elect to record these training sessions for future training purposes. The resulting tapes shall be the sole property of the City and for the sole use of the City.

The training shall not be held until after the successful completion of the Operational Test.

5 TESTING

The following specification describes the required testing of the equipment and software to be provided as integrated components of the ATMS.

5.1 FACTORY ACCEPTANCE TESTING

All equipment furnished as a part of this contract shall be tested at the factory prior to shipment to determine conformance with all applicable requirements.

The City reserves the right to perform at its own expense any inspections or testing deemed necessary to insure that the equipment conforms to the requirements in this specification.

The Vendor shall provide a certified letter from the manufacturer confirming the completion of the Factory Acceptance Testing.

5.2 TESTING DURING THE OPERATIONAL TEST

The purpose of the Operational Test shall be to allow City personnel to verify that the system complies with the specifications and to provide the opportunity to make required changes prior to completion of the entire order. All items purchased in the initial procurement shall be tested together as an integrated system.

The Vendor shall provide all necessary assistance to insure completion of this test.

5.3 FINAL SYSTEM ACCEPTANCE TEST

At least fifteen days before the start of the Final System Acceptance Test the Supplier shall submit to the City an Acceptance Test Plan. This test plan will be reviewed by the Signal Systems Supervisor, who shall either approve or indicate changes that are required for approval within seven (7) days of receipt. Once approved, the test may commence at a time mutually agreed upon by the City and the Supplier.

The purpose of the Final System Acceptance Test shall be to verify that the entire system, complete and in place, functions properly and in accordance with the specifications.

The Final System Acceptance Test shall not be completed until all items conform to the specification as approved by the City Signal System Supervisor and all training has been completed.

The Final System Acceptance Test shall include the successful completion of a thirty (30) day test period in which the entire integrated system functions without failure.

The Vendor shall document and complete all necessary tests. The City shall monitor these tests to insure their successful completion.

6 PAYMENT

Invoices for payment can be made as monthly statements for items delivered in each month, less a ten (10) percent retainage. The retainage for all items shall be released upon successful completion of the final system acceptance test.

ANNEX C: TEST PLANS

The RFP did not include any specifics regarding testing requirements in terms of NTCIP conformance. During the course of the project, a conformance punchlist was developed, which was checked during the acceptance testing phase.

Please contact Arthur Dock of the City of Mesa Department of Transportation (480-644-3128 or arthur_dock@ci.mesa.az.us) for further details.

ANNEX D: THE NTCIP STANDARDS PROCESS

During the standards development process, all NTCIP standards progress from through a series of stages. These stages are described below:

- **Proposal** – Someone submits an idea.
- **Working Draft** – The idea is reviewed in committee and goes through an iterative editing process.
- **User Comment** – When the Working Group reaches a reasonable level of consensus on the draft, it is submitted to the Joint Committee and upon their approval, it is distributed for user comments.
- **Recommended** – The Working Group has reached consensus on the document and the Joint Committee elevated the standard to this level by a 2/3rds vote. Typically, the Joint Committee also decides to send to ballot at this point.
- **Approved** – All three Standard Development Organizations balloted the standard, received enough affirmative votes, and have approved the document through their legal department, the standard reaches this level.
- **Published** – After a standard is approved, it then goes to the editorial group who is responsible for proper formatting and copyright statements. Once it is available in published form, the file is removed from the Web Site and the SDOs start charging a fee for it.

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