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Considerations for a Guide to Contracting ITS Projects

Prepared for:

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TRANSPORTATION RESEARCH BOARD

OF THE NATIONAL ACADEMIES

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EXECUTIVE SUMMARY

Through research and lessoned learned from early [ITS] deployers, it has been concluded that the procurement of goods and services to support ITS deployments represents a major obstacle for transportation agencies responsible for deploying ITS. This obstacle can be attributed to the challenges associated with the procurement of goods and services to support the deployment of complex information technology (IT) systems. In response to this challenge, innovative procurement methods have been established.

In order to overcome the challenge of procuring ITS, transportation agencies must institutionalize innovative procurement methods. The first step towards this requires that transportations agencies become aware of innovative procurement methods and their appropriate usage. Concurrently, federal, state and local procurement policies, practices and procedures have to be considered and possibly tweaked to accommodate innovative procurement methods.

The use of inappropriate procurement methods may result in project cost-overruns, final designs that do not satisfy functional requirements and long-term maintenance failures. An appropriate method of procuring ITS must be flexible enough to accommodate the uncertainties of complex system acquisitions, while at the same time rigid enough to ensure that the responsibilities of the participants are fully defined and their interests protected.

In an effort to aid state and local transportation agencies with the identification of appropriate innovative procurement methods, the National Cooperative Highway Research Program (NCHRP) funded NCHRP Project 03-77 with the objective of developing a guide to ITS procurement.

A research team was established to develop the guide. The research team included veteran ITS and procurement practitioners with a wealth of experience in procuring complex IT systems. An NCHRP research panel was established to oversee the development of the guide. The project also involved the development of a website, a final report and complimentary outreach materials. The website automates the process prescribed in the guide.

As a result of this research it was determined that project, agency and environment characteristics and systems engineering and project management principles are key inputs into the process used to identify an appropriate procurement approach for a specified ITS project. A decision model (presented in Figure 1 on page 3) was developed to represent this process. The Decision Model includes eight steps that must be performed to complete the process of defining the most appropriate procurement approach for an ITS project:

> **Step 1 – Initial Decisions**: Step one will aid users in making fundamental procurement decisions that will ultimately affect the overall procurement strategy. These fundamental decisions consider the possibility of outsourcing and the procurement of consultant services. This step also directs users to skip to Step 7 of the Decision Model if either outsourcing or consultant services are used.

Step 2 – Work Distribution: Step two will help users determine whether the procurement should be performed as a single contract or multiple contracts.

Step 3 – Define Project Category: Step three will help users categorize your project with respect to complexity and risk. Understanding project complexity and risks is critical to determining an appropriate procurement package.

Step 4 – Determine Agency Capability Level: Step four will assist users in assessing transportation agency resources and capabilities as well as the environment in which the project will be procured.

Step 5 – Select Applicable Systems Engineering Process & Candidate Procurement Package: Step five uses the results of steps three and four to select applicable systems engineering processes and candidate procurement packages.

Step 6 – Apply Differentiators: Step six applies differentiators to the candidate procurement packages identified in step five. This step will help users reduce the number of procurement packages identified in step five.

Step 7 – Package Assessment and Final Selection: This step suggests the involvement of agency procurement personnel to assist in making the final selection of the most appropriate procurement package.

Step 8 – Define Contract Scope & Terms and Conditions: The final step will assist users with the selection of the necessary terms and conditions to be included in the contract.

The guide further explains each step. Tables and worksheets are provided to aid guide users in executing the decision model.

The products of this research effort provide transportation professionals with tools to aid in the identification of appropriate innovative procurement strategies for a specific ITS project. In order to further advance the use of innovative procurement strategies to procure ITS, an aggressive outreach campaign is suggested that includes:

- Preparation and dissemination of brochures and other announcements intended to inform the profession of the availability of this research and the potential benefits of its use

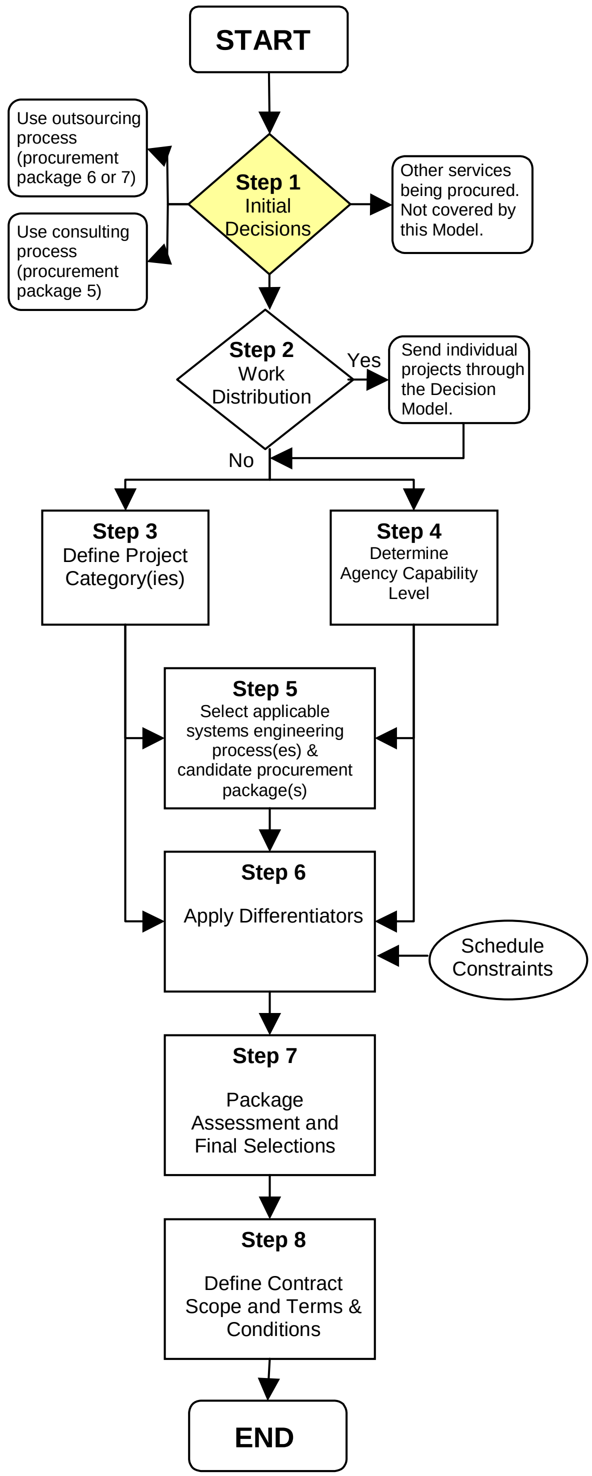

Figure 1 Decision Model

- Preparation and delivery of training courses (either on-line or classroom) to instruct ITS professionals on the use of the guidelines
- Integration of the guidelines into existing curricula of the Federal Highway Administration's Professional Capacity Building Program including existing systems engineering and project management courses. Training should also be provided to FHWA field personnel regarding the availability of the guidelines and their application to the ITS procurement process.
- Inclusion of papers and presentations describing this work at national conferences sponsored by ITS America, the Institute of Transportation Engineers and NTOC.
- Offers of assistance through the FHWA Peer-to-Peer program, to agencies contemplating ITS procurements. This requires provision of prior training to Peer-to-Peer personnel in the use of the guidelines.

Suggested follow-up research activities include:

- Testing the decision model presented in the guide.
- Further consider the impact of organizational structure on ITS procurement.
- Integration of the results of this research into the systems engineering process.

CHAPTER I
INTRODUCTION AND RESEARCH APPROACH

INTRODUCTION

Transportation professionals are placing increased emphasis on transportation system management and operations (TSMO[1] *tiz-mo*) enhancements versus capital improvements as solutions to transportation challenges. In some cases, TSMO enhancements are included within capital improvement projects. TSMO solutions often require the application of Intelligent Transportation Systems (ITS) technologies. ITS can be defined as information technology (IT) based systems, which along with their required communications infrastructure are used to improve the efficiency or safety of surface transportation. That being said, transportation professionals are now faced with the well-documented challenge of procuring IT.

Fortunately, transportation professionals do not have to tackle the challenge of procuring IT alone. Innovative procurement strategies have already been [and are currently being] developed that can help overcome this challenge. These procurement strategies utilize design-build and systems manager contracts and specified contract terms and conditions to ensure a successful IT procurement. In many cases, existing procurement policies, practices and procedures within the transportation organizations discourage the use of these strategies. Therefore, the two challenges faced by transportation professionals when considering the procurement of ITS are:

1. Identifying appropriate innovative procurement strategies.
2. Identifying and overcoming any restrictions imposed by existing procurement policies, practices and procedures.

Through NCHRP Project 03-77, a guide to ITS contracting has been developed to help transportation professionals mitigate these challenges. The guide presents a method for identifying appropriate ITS procurement strategies based on project and agency characteristics and constraints. Once transportation professionals have identified an appropriate procurement strategy, they are encouraged to consult agency procurement officials. At this stage, restrictions imposed by existing procurement policies, practices and procedures are identified and options for working within this environment can be formulated.

RESEARCH OBJECTIVE

The objective of NCHRP Project 03-77 is to develop an ITS contracting guide that will provide a method for identifying appropriate ITS procurement strategies based on project and agency characteristics and constraints. This project also includes the production of an Executive Summary, brochures, and presentation materials that will promote the use of concepts presented in the guide. In addition, a website has been developed to automate the use of the procedures included in the guide.

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[1] TSMO concepts are further defined in Getting More by Working Together – Opportunities for Linking Planning Operations.

RESEARCH APPROACH

The following tasks outline the research approach.

Tasks 1 and 2 – Literature Review and Survey of Contracting Methods

The objectives of tasks 1 and 2 are to:

1. Conduct a literature review of both transportation and non-transportation references.
2. Conduct a survey of local and state departments of transportation agencies in order to better understand the state of the practice [with respect to procuring ITS].

Much of the data collection for this effort came from an extensive review of existing literature from both the public and private sectors. Sources included:

Transportation Sources	Non-Transportation Sources
o Transportation Research Board (TRIS Online) o JPO Electronic Document Library (EDL) o JPO Professional Capacity Building Materials o Institute of Transportation Engineers o ITS America Meeting Proceedings o State DOT Websites/Reading Rooms o FHWA/Turner-Fairbanks Highway Research Center o ITS Cooperative Deployment Network (ICDN) o AASHTO	o US Department of Defense o US General Accounting Office o US Department of Agriculture o US Department of Management and Budget o US Department of State o State and Federal Procurement Regulations (FAR, COMAR, etc.) o National Association of State Purchasing Officials o National Association of State Information Resource Executives o National Association of State Directors of Administration and General Services o Private [IT] Corporations (Unisys, IBM, etc.)

As a result of this review, an extensive database of procurement references has been developed. The references presented in this database, as shown in Appendix A, served as the starting point for this research.

The information obtained from this extensive literature search was supplemented by a survey of state and local departments of transportation to obtain information about their current ITS procurement and contracting practices. The developed survey was web based. An email invitation to participate in the survey was distributed to select state transportations agencies including:

- Virginia Department of Transportation
- Texas Department of Transportation
- Kentucky Transportation Cabinet

- New York State Department of Transportation
- Illinois Department of Transportation
- California Department of Transportation
- North Carolina Department of Transportation

A survey instrument was developed by the research team and approved by the research panel. The survey solicited information on current practices and experiences with ITS contracting. The survey was followed-up by telephone to discuss the survey respondent's response to the survey.

The results of this task are summarized in Chapter II.

Task 3 – Categorize ITS Projects

The objective of task 3 was to categorize ITS projects based on a number of factors including complexity of the project, the level of new development required, the scope and breadth of technologies involved, the amount of interfacing to other systems, the likelihood of technology evolution, and the fluidity of the requirements. Together, these factors influence the level of risk associated with an ITS project. Project risk may be defined in terms of schedule, quality, cost, or requirements risks. These risks can increase or decrease significantly based on the above factors and their associated characteristics. For an ITS project to be successful, it is important that the procurement process take into account the level of risk involved with a project. Thus, a thorough understanding of these factors, their associated characteristics, and their influence on the overall risk associated with ITS projects is very important.

Table 1 (page 8) provided a starting point for identifying generic ITS project categories along with the factors and characteristics that support their definitions. The "starting point" included four ITS project categories ranging from "low" overall risk for a Category 1 project to "very high" overall risk for a Category 4 project. Table 1 also included a brief general description of a system implementation that might represent a particular ITS project category.

Therefore, task 3 validates Table 1 as an appropriate categorization of ITS projects. Even more important, an effort was made to validate the factors and their associated characteristics as they will ultimately be most useful in selecting the procurement components that can best address the overall risk associated with an ITS project.

Table 1. ITS Project Categories

	Category 1	Category 2	Category 3	Category 4
Complexity	Simple	Moderately complex	Complex	Extremely complex
Level of New Development	Little to no new software development / exclusively COTS based or based on existing proven software	Primarily COTS software or existing software based with some new software development or new functionality added to exisitng software - evolutionary development	New software development for new system, replacement system, or major system expansion including use of COTS software	Revolutionary development - entirely new software development including integration with COTS or existing legacy system software
Scope & Breadth of Technologies	Application of proven, well known, and commercially available technology. Small scope in terms of technology implementation	Primarily application of proven, well known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation	Application of new software along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in terms of technologies to be implemented	New software development combined with new hardware configurations/components, use of cutting edge comm technology. Very broad scope of technologies to be implemented
Interfaces to Other Systems	No interfaces to external systems or system interfaces are well known (duplication of existing interfaces)	System interfaces are well known and based primarily on duplicating existing interfaces	System interfaces are largely well known but include interfaces to new existing systems/databases	System requires interfaces to both new and existing internal/external systems and plans for interfaces to "future" systems
Technology Evolution	Little to no impact on system in terms of technology evolution	Little to minor impact on system in terms of technology evolution. May involve only upgrades of COTS software	Technology evolution likely to have moderate to signifcant impact and must be adequately accounted for in system design	Technology evolution very likely with potential major implications on system to be implemented
Requirements Fluidity	System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity	System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management	New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processess	System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes
Overall Risk	Low	Moderate	High	Very high
General ITS Project Example	Expansion of existing systems…adding additional field devices (CCTV, DMS, etc).	Implementation of computerized signal system.	Replacement of existing TMC software with the addition of new system functionality.	New TMC system implementation including field devices, interfaces to internal/external systems, etc.

The ITS project category validation was a subjective process that started with collecting a diverse cross section of real-world ITS project examples. Information was collected on over 200 ITS projects from the year 2000 to present, the sources of which were primarily AASHTO and US DOT operations and ITS web sites. Each project was given a cursory review within the context of the previously defined Categories in Table 1 (page 8). The purpose of this initial cursory review was to (1) find a short list of examples that represented the previously defined Categories and (2) to determine if there were projects that didn't seem to fit within these Categories, hence requiring the addition of a category. A short list of 50 projects was developed that represented various types of the following systems.

- Arterial Management Systems
- Freeway Management Systems
- Transit Management Systems
- Emergency Management Systems
- Electronic Toll Collection Systems
- Electronic Fare Payment Systems
- Traveler Information Systems
- Weather Systems
- Rural Transit Mobility
- Rural Traffic Management
- Operations & Maintenance
- CVO/CVISN Systems

A matrix was then developed to ensure that there was a good distribution of projects across categories and system types, the rationale being that the ITS project categories, factors, and associated characteristics should, to the extent possible, be representative of many types of systems and not just, for example, freeway management systems. Next, at least four projects were selected that represent each ITS project category. Projects were also selected to represent the wide variety of system types. A total of 19 project examples were ultimately selected and an effort was made to describe each based on the factors and associated characteristics in Table 1. In this step, additional detailed information was sought for the ITS project examples through transportation agency or project specific web sites.

The results of this task, including an updated version of Table 1, are presented in Chapter II.

Task 4 – Systems Engineering Process

The proposed objectives of task 4 were to:

- Provide a description of both systems engineering and contracting concepts; and,
- Describe relationships and interactions between systems engineering and contracting concepts.

In conducting this task, it was determined that project management principles should also be described and related to both systems engineering and contracting concepts.

Relevant knowledge and experiences of the research team and the research panel as well as references obtained in Tasks 1 and 2 were used to derive the relationships between systems engineering, project management and contracting documented in Chapter II.

Task 5 – Recommend Contract Types

The objective of Task 5 was to describe the process of planning and executing a system procurement. However, procurement planning cannot be performed in isolation, and for this reason, the Task 5 activities also consider the initial planning activities that must precede procurement planning (designated project planning in this report).

The procurement aspects of the planning process described led to the development of a decision model that will assist agencies in the selection of the procurement alternative best suited to their agency's capabilities and the characteristics of the system being considered for procurement. Real world ITS Projects were used to test the utility of the decision model.

The results of this task are presented in the Chapter II.

Task 6 – Prepare a detailed Outline of the Guide

Based on the results of Tasks 1 through 5 a draft detailed outline of the "Guide to Contracting ITS" was developed. The research panel reviewed the outlined. Comments from the review panel were considered and a final version of the detailed outlined was generated.

Task 7 – Prepare the Guide

Based on the results of Task 6, a draft "Guide to Contracting ITS" was developed. The research panel reviewed the guide. Comments from the review panel were considered and a final version of the guide was generated.

In addition to the guide, a website (http://www.citeconsortium.org/) was developed to automate the use of the guide.

Task 8 – Submit Report

The concluding task was to prepare a research report documenting the entire effort for the NCHRP Project 03-77.

CHAPTER II
FINDINGS

TASKS 1 AND 2 – LITERATURE REVIEW AND SURVEY OF CONTRACTING METHODS

As indicated in Figure 2 (page 12), the literature review yielded 117 references, and of those 117 references 39 were identified for further review. All of the references considered are presented in NCHRP format in Appendix A.

There is an extensive bibliography of references describing both ITS and general IT procurements. As might be expected, many of these references address specific experiences without referencing the success or failure of their application. For this reason, they were not included in the list of recommended references. In addition, while there are many more non-transportation related references than transportation (ITS) related references, many were not included because they were not applicable to the ITS industry and the public-sector procurement constraints.

Innovative Contracting Methods/Procurement Approaches

Procurement components are combined to form a procurement approach based on project goals and objectives. Innovative procurement approaches are combinations of new or established procurement techniques that have been used to produce a novel procurement approach. The literature review produced both novel procurement components and procurement approaches.

Pre-Qualification and Negotiation

The literature review indicated that the pre-qualification of vendors is becoming increasingly popular among state and local government agencies, the fundamental premise being that the pre-qualification of vendors streamlines the procurement process. Government agencies can use the pre-qualification process to either short-list vendors for a particular procurement or to identify vendors to contract for "indefinite quantities". Through pre-qualification, state and local government agencies are not burdened with reviewing the multitude of responses to solicitations for services and/or goods. Therefore, state and local government agencies can utilize more of their resources on negotiations with respect to the scope-of-work and other considerations. This streamlined process produces a positive effect on the project outcome. Procurement approaches that incorporate this streamlined process include:

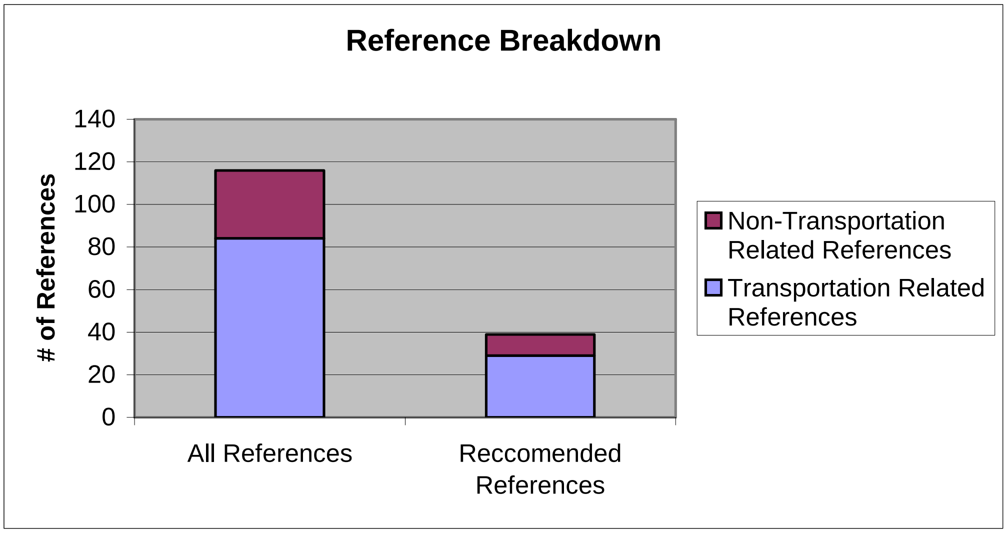

Figure 2. Summary of Literature Search Results

- Indefinite Quantities Contracts (IQC)/Indefinite Delivery Indefinite Quantities (IDIQ) Contracts
- The Information Technology Omnibus Procurement (ITOP) Program[2]
- Invitation to Negotiate (ITN)

Invitation to Negotiate (ITN)

The ITN procurement process used throughout the State of Florida provides a novel approach for procuring ITS. An overview of the activities involved in the ITN procurement approach is outlined below:

Step 1) FDOT develops and releases an ITN.
Step 2) Interested vendors respond to the ITN.
Step 3) Interested vendor responses are reviewed and either ranked or included in a next iteration of the ITN scope. The next iteration of the ITN scope will be only distributed to a "short-list" of best-qualified vendors based on the responses to the initial ITN.
Step 4) Once the ITN scope has been finalized and re-distributed, then vendors are ranked according to their final responses.
Step 5) The highest ranked vendor is selected for contract negotiations.

The ITN procurement approach has been chosen for several ITS deployments by the Florida Department of Transportation. FDOT utilizes the ITN procurement approach when they intend to procure technologies that are at their infancy stage of development. This is done in recognition of the fact that procurement of "cutting edge" technologies is hard to scope and therefore, introduces a lot of risks. The ITN procurement approach is intended to mitigate these risks. The effectiveness of this approach is still under evaluation.

Performance-Based Contracting

Performance-based contracting is a good option for select ITS procurements. A performance-based contract specifies the final outcome of a task or project and leaves the method used to reach the final outcome up to the contractor/consultant. The task or project objectives are translated into measurable/quantifiable specifications. Successful completion of the task or project is gauged by these measurable/quantifiable specifications. The use of performance-based contracts produces the following benefits[3]:

- Enhances relationship between contractor and client
- Motivates the development and implementation of new ideas
- Innovative ideas, methods to keep quality high while reducing cost
- Direct relationship between performance and pay
- Creates greater ownership, commitment and accountability by the contractor
- Provides for greater management attention to the project

[2] http://www.eds-gov.com/itop2/
[3] Based on project reference ID: 53, *Guideline to Managing Performance Based Operations and Maintenance Contracts*.

- Improves project execution, data collection and management
- Contractor assumes some associated risks

However, within the TSMO field, difficulties have been encountered with the definition of performance criteria (other than meeting schedules) that can be reliably quantified.

Design-Build

The design-build work allocation method has long been identified as a tool for successful procurement of ITS. Several innovative permutations and variations of the design-build work allocation method have been established. For instance, the design-integration work allocation method is gaining popularity in other industries.

The Connecticut Department of Transportation (ConnDOT) utilized a unique variation of the design-build work allocation method to procure an advanced traffic data collection system. ConnDOT inserted a proof step in between the design and build steps. The proof step required the contractor to develop and test a prototype of the proposed system. Additionally, the contractor was required to conduct a system demonstration test. The proof step identified problems areas sooner, which made field-testing easier. The test also reduced the risk of incurring multiple change orders during the integration phase of the project.

Survey of Contracting Methods Employed by ITS Agencies

This section presents the results obtained from a web-based survey directed to ITS agencies. The objective of this survey was to understand the current practice for contracting ITS projects across the agencies. The survey was aimed at ITS project managers and agency procurement officials.

Survey Responses

The following paragraphs present details on the agencies' practices for contracting ITS projects.

Survey Respondents

The total number of respondents was 13, which represented five agencies. These agencies are Kentucky Transportation Cabinet, Illinois Department of Transportation, New York State Department of Transportation, Texas Department of Transportation, and Virginia Department of Transportation (see Figure 3 on page 15).

ITS Organizational Information of Agencies

Although, 62% of the respondents have recognized that their agency has an organizational unit specifically appointed for the acquisition and management of ITS systems, almost half of the respondents acknowledged that their agency uses outside assistance to manage/oversee ITS project acquisitions.

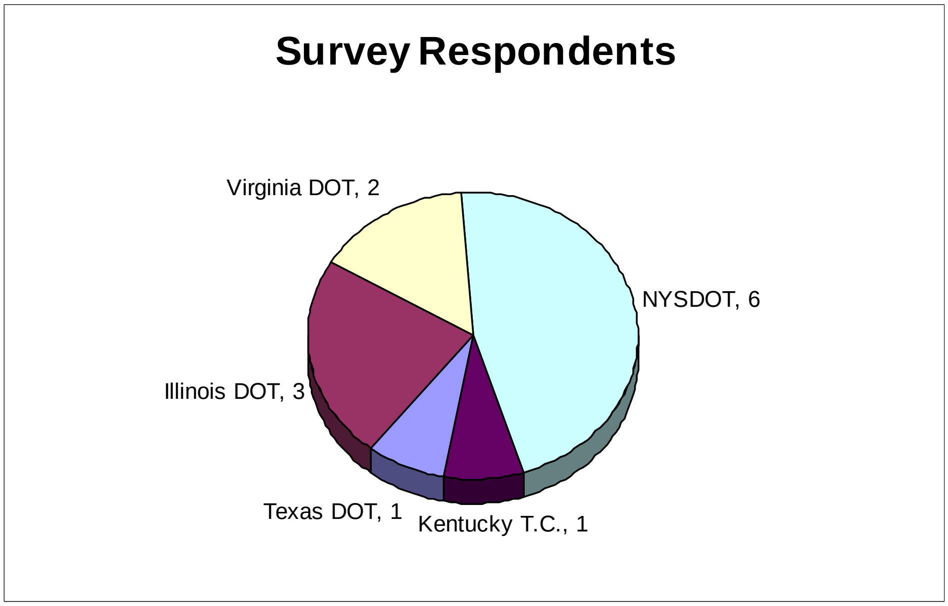

Figure 3. Summary of survey respondents

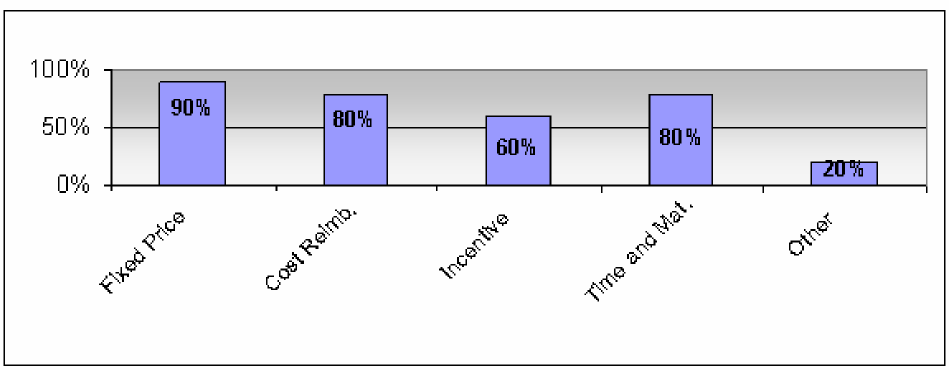

Figure 4. Types of Contractor/Consultant Reimbursement Permitted.

The survey also showed that 4 out of 5 agencies have the following in-house areas of expertise: IT System Administration, IT System Maintenance and IT System Operations.

Procurement Policies and Regulations

Only 2 of the 5 agencies allow Design-Build contracting; these agencies are Virginia DOT and Kentucky TC.

Figure 4 (page 15) shows the percentage of agencies surveyed that use different types of contractor/ consultant reimbursement vehicles.

Moreover, the survey shows that 71% of the respondents reported that cost-reimbursable contracts require a ceiling; 57% of them stated that their agency does not restrict the maximum allowable overhead and does not have a limit on allowable fees (profits). 78% of the respondents reported that their organization uses indefinite quantity (task order) type of contracts.

All respondents acknowledged that their agency has a policy for intellectual property rights; one third of them reported that the agency has ownership or unrestricted license to use of all products developed under contract.

One hundred percent of the agencies reimburse consultants and contractors for project management cost. Likewise, all agencies permit sole source acquisition of proprietary software packages (MS Windows, Oracle, etc) as well as the acquisition of off-the-shelf application software (traffic management software, signal control software, dispatch software, etc). Only 30% of the respondents acknowledged that they have incorporated incentives in ITS contracts while 50% of them have incorporated penalties.

Finally, the survey shows that 56% of the respondents indicate that their agencies use IT industry certifications (such as the Capability Maturity Model (CMM) or ISO 9000) as a pre-qualification criteria during the procurement process.

TASK 3 – CATEGORIZING ITS PROJECTS AND ASSESSING AGENCY ITS CAPABILITIES

Task 3 involved development of a method for categorizing ITS projects based on a number of key project factors and associated characteristics that can be used to identify a project in terms of its overall complexity and risk. For an ITS project to be successful, it is important that the procurement process take into account the level of risk. Equally critical to procurement is an agency's resources and capabilities along with the "environment" in which a project is planned, designed, deployed, and operated.

Categorizing ITS Projects

Four categories of ITS Projects have been defined as follows:

- Category 1: Straightforward in terms of complexity and low overall risk
- Category 2: Moderately complex and moderate overall risk
- Category 3: Complex with high overall risk
- Category 4: Extremely complex with a very high overall risk

Project risk may be defined in terms of schedule, quality, cost, or requirements risks[4]. These risks can increase or decrease significantly based on the following factors and their associated characteristics:

- **Complexity**. The characteristics that describe this factor define the level of difficulty associated with implementing an ITS project in a particular category. The level of difficulty is directly related to subsequent factors and their associated characteristics.

- **Level of New Development**. The characteristics that describe this factor describe the use of commercial off the shelf (COTS) software and/or hardware compared with the level of new software development and/or hardware implementation associated with an ITS project implementation. The level of new development, particularly software development, typically has a significant impact on the overall risk associated with an ITS project.

- **Scope and Breadth of Technologies**. The characteristics that describe this factor include: (1) the level of technology implementation; and (2) the scope of technologies implemented by an ITS project. Levels of technology implementation range from the application of proven, well-known, and commercially available technology to the use of cutting edge technology. Scope refers to the range of technology implemented. For example, the scope associated with a Category 1 ITS project might involve installation of new field devices such as CCTV cameras that will be controlled by an existing traffic management center. On the other end of the spectrum, the scope associated with a Category 4 ITS project might involve, for example, construction of a new traffic management center building, installation of field devices (e.g., detectors, CCTV cameras, variable message signs, vehicle probe technology based on cellular geo-location), new central control system software with entirely new functionality, system of wire-line and wireless communications technologies, interfaces to transit, public safety, and commercial vehicle systems and databases. Another scope related characteristic involves the concept of phasing. Category 1 and 2 projects may be done as a single stand-alone project involving only one phase. Due to the complexity of Category 3 and 4 projects, they typically involve multiple phases, which is consistent with good practice (good practice being to break up large projects into small manageable pieces). Category 1 and 2 projects may actually be part of phases

[4] *Intelligent Transportation System (ITS) Software Integration Project Risk Assessment and Mitigation*, 2002, Yermack, Larry, and Iserson, Andy, prepared for AASHTO.

under Category 3 and 4 projects. This is significant in that a Category 3 and 4 project may use a diverse mix of procurement components as opposed to a "one-size fits all" approach.

- **Interfaces to Other Systems**. The characteristics that describe this factor are based on the number of major subsystems as well as the number and complexity of existing and new system/database interfaces that will be included in an ITS project implementation. This ranges from no major subsystems and interfaces (or a duplication of well-known existing interfaces) for a Category 1 ITS project to a Category 4 ITS project that might include multiple major subsystems and multiple interfaces to new and existing systems both internal and external to the implementing agency as well as planning for future interfaces that don't yet exist.

- **Technology Evolution.** The characteristics that describe this factor are based on an agency's "perceived need" to account for the evolution of technology. The fact is that, with any category of ITS project, the probability of technology evolution is 100%. Technology installed today will "evolve" within a matter of weeks or months depending on what it is. Quite often, technology specified in procurement documents is outdated by the time it actually gets installed. Standards are often identified as a way to account for technology evolution; however, in some cases the rapid rate of technical progress leaves formal standardization efforts slow to catch up if the standards are formulated by relatively slow moving and deliberate standard-setting bodies[5].

The idea of "perceived need" comes into play more for Category 1 and 2 projects. For example, an agency may consciously decide to implement CCTV camera hardware and control software that is compatible with their existing system. While this technology is evolving, an agency's perceived need to take this into account may be influenced by having to wait for the emergence of CCTV standards and the associated vendor equipment that meets the standards. In this case, the agency will likely opt to deploy equipment based on their existing equipment and software. At some point in the future, as standards based CCTV equipment comes to market, the agency may decide to make changes to their central control system software so that they can deploy standards based hardware from different vendors in the future. When it comes to Category 3 and 4 projects, the need for taking technology evolution into account should be based less on perceived need and more on actual need. The reality is that the agency really doesn't have a choice but to take technology evolution into account. For example, an ITS project that involves implementation of a mobile data communications system in conjunction with automatic vehicle location for service patrol vehicles will be impacted significantly by rapid changes in wireless communications technology. Technology evolution, in this case, is an actual need since not accounting for it can have a major impact on the long-term viability and ultimate success of the system.

In addition to the agencies perceived need to account for changing technology, it is helpful to think of technology evolution in terms of the expected usable life of a system, its subsystems, components, and underlying technology (both hardware and software).

[5] Association for Information Systems (AIS)

Characteristics used to describe useful life under this factor include the terms “short”, “moderate”, “long”, and “extendable”. From a technology standpoint, short could be considered 3-5 years; moderate could be considered 5-7 years; and long could be considered 7-10+ years. The term “extendable” implies that a particular technology or component’s life may be extended at the end of its initial life. It is, however, difficult to apply the concept of expected useful life to an overall system. Therefore, these terms are used in Table 2 (page 20) to describe three separate components of an ITS project: field devices, center-based hardware, and control system software, all of which can be expected to have different expected useful lives.

- **Requirements Fluidity**. The characteristics that describe this factor are based on how well requirements are understood and defined upfront along with the likelihood of requirements changes during the ITS project implementation. The characteristics also describe the level of requirements management that may be necessary based on the category.

- **Institutional Issues**. The characteristics that describe this factor are intended to describe an ITS project in terms of, for example, the need for new agreements (either intra or inter agency), modifications to existing business models, working relationships, or operational procedures, and a general need to work with non-traditional partners. Not addressing these issues in an ITS Project can lead to the failure of a technically successful implementation.

- **Overall Risk**. This is a brief description of the overall risk associated with a category and is based on all of the prior factors and their characteristics. The Overall Risk ranges from “low” for a Category 1 ITS Project to “very high” for a Category 4 ITS project.

Table 2 identifies four ITS project categories ranging from “low” overall risk for a Category 1 project to “very high” overall risk for a Category 4 project. Within each of the four categories, detailed characteristics are provided for each of the above factors.

The worksheet in Appendix C has been developed to assist with determining the ITS Project Category (complexity and risk).

Table 2. ITS Project Categories

	Category 1	Category 2	Category 3	Category 4
Complexity	Straightforward	Moderately Complex	Complex	Extremely Complex
Level of New Development	Little to no new software development / exclusively COTS software and hardware based or based on existing proven software and hardware.	Primarily COTS software / hardware or existing software / hardware based with some new software development or new functionality added to existing software - evolutionary development.	New software development for new system, replacement system, or major system expansion including use of COTS software. Implementation of new COTS hardware.	Revolutionary development - entirely new software development including integration with COTS or existing legacy system software. Implementation of new COTS hardware or even prototype hardware.
Scope & Breadth of Technologies	Application of proven, well-known, and commercially available technology. Small scope in terms of technology implementation (e.g., only CCTV or DMS system). Typically implemented under a single stand-alone project, which may or may not be part of a larger multi-phased implementation effort.	Primarily application of proven, well-known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation (e.g., multiple technologies implemented, but typically no more than 2 or 3). May be single stand-alone project, or may be part of multi-phased implementation effort.	Application of new software / hardware along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in terms of technologies to be implemented. Projects are implemented in multiple phases (which may be category 1 or 2 projects).	New software development combined with new hardware configurations/componen ts, use of cutting edge hardware and/or communications technology. Very broad scope of technologies to be implemented. Projects are implemented in multiple phases (phases may be category 1 or 2 projects).
Interfaces to Other Systems	Single system or small expansion of existing system deployment. No interfaces to external systems or system interfaces are well known (duplication of existing interfaces).	System implementation includes one or two major subsystems. May involve significant expansion of existing system. System interfaces are well known and based primarily on duplicating existing interfaces.	System implementation includes three or more major subsystems. System interfaces are largely well know but includes one or more interfaces to new existing systems / databases.	System implementation includes three or more major subsystems. System requires two or more interfaces to new and/or existing internal/external systems and plans for interfaces to "future" systems.

	Category 1	Category 2	Category 3	Category 4
Technology Evolution	Need to account for technology evolution perceived as minor. Example would be to deploy hardware and software that is entirely compatible with an existing COTS-based system. Ramifications of not paying particular attention to standards considered minor. System implemented expected to have moderate to long useful life.	Need to account for technology evolution perceived as an issue to address. Example includes desire for interoperable hardware from multiple vendors. Ramifications of not paying particular attention to standards may be an issue, as an agency may get "locked-in" to a proprietary solution. Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have moderate to long life.	Need to account for technology evolution perceived as a significant issue. Examples might include implementation of software that can accommodate new hardware with minimal to no modification and interoperable hardware. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.	Need to account for technology evolution perceived as major issue. Examples include software that can easily accommodate new functionality and/or changes in hardware and hardware that can be easily expanded (e.g. add peripherals), maintained, and are interoperable. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.
Requirements Fluidity	System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity.	System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management.	New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processes.	System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes.
Institutional Issues	Minimal- project implementation involves one agency and is typically internal to a particular department within the agency.	Minor- may involve coordination between two agencies. Formal agreements not necessarily required, but if so, agreements are already in place.	Significant- involves coordination among multiple agencies and/or multiple departments within an agency or amongst agencies. Formal agreements for implementing project may be required.	Major- involves coordination among multiple agencies, departments, and disciplines. Requires new formal agreements. May require new multi-agency project oversight organization.
Overall Risk	LOW	MODERATE	HIGH	VERY HIGH

Assessing Agency ITS Capabilities

While an understanding of the above ITS project specific factors is critical to selecting the best procurement approach, there are a number of non-project related factors that will influence the optimal mix of procurement components (The next section on Task 4 discusses the following four procurement components: work allocation, method of award, contract form, and contract type). The following factors and associated characteristics pertain to an agency's (or organization's) capability to successfully manage an ITS project implementation (see Table 3 on page 23). Agency capability factors include:

- **Personnel Experience.** It is critical that an agency, to the extent possible, have the necessary personnel with the appropriate experience and skills to oversee an ITS project implementation (ideally these are in-house personnel). Getting agency personnel actively involved in the design, development, implementation, operations, and maintenance is important to a successful ITS implementation, but this active involvement takes considerable amount of time and effort. These individuals might include (but is certainly not limited to) system administrators, maintainers, operators, software expertise, and even contracting and purchasing personnel that can help put together the best mix of procurement components together.

Agencies can also take advantage of expertise of Information Technology (IT) personnel either within or outside their departments. This expertise can take the form of technical expertise (e.g., hardware, software, communications) or even IT procurement expertise. While coordination with IT staff is advocated, relinquishing the authority for doing technology procurements (e.g., moving responsibility for procuring ITS related hardware, software, and communications from the DOT to another State department responsible for IT) is not necessarily recommended.

- **Organizational Experience.** An agency's experience with implementing ITS projects will have an impact on an ITS implementation. This doesn't imply that agencies who have implemented dozens of ITS projects do not experience any problems. However, they do have a feel for pitfalls to avoid and generally have had some time to put together a mix of in-house and consultant personnel that have the skills and experience to improve the success of an ITS implementation.

- **Organizational Structure.** Whether or not an agency is organized to support ITS projects can be critical to implementation success. While there may be aspects of an ITS implementation that are handled within an existing organizational structure, there may be a need to create new teams or offices devoted to, for example, ITS Operations, Development, Integration, etc. The more involved in ITS an agency gets, the more important it is for an agency to be organized to support developing and deployed systems, especially over the long-term.

Table 3. Agency Capability Levels

	Level 1	Level 2	Level 3
Personnel Experience	ITS assigned as part-time job to person with no staff and little to no specific ITS experience.	ITS assigned as full-time job with no staff or some part-time staff support. Person assigned has some specific ITS experience with Category 2 or 3 projects. Staff support (if it exists) has little to no ITS experience.	Full-time ITS Manager and staff with significant prior ITS experience. Staff support includes system administration, operations, and maintenance responsibilities.
Organizational Experience	Little to no experience with the possible exception of Category 1 ITS projects.	Experience with at least one Category 2 or greater project.	Experience with at least one Category 3 or greater project.
Organizational Structure	ITS responsibility not defined. Responsibility housed within organization with other mission or primary responsibility. Responsibility may also be scattered amongst organizational entities with no clear lines of responsibility.	ITS responsibility somewhat, but not adequately defined. Individual organizational units have ITS responsibility and have their own budgets, management and priorities; however, there are no definitive linkage between these units. An umbrella ITS organizational unit may exist, but may not have the budgetary authority to effectively manage sub-units.	Established organizational unit with budgetary authority and clear ITS responsibilities. Organizational unit ties all ITS responsibilities together and includes a procurement process that supports ITS acquisition (e.g., personnel, policies, and procedures).
Resources	Little to none. No identifiable ITS budget categories or identification of specific ITS funding within existing organizational units.	Some budget resources (e.g., ITS earmark funding) assigned to one or more existing organizational unit(s). Support for personnel, equipment, office space, and training expected to come from organizational unit(s) existing budget.	Identifiable budget category set aside for ITS. Budget includes support for all required personnel, support equipment, office space, training, and (if necessary), consulting support.
Management Support	Some mid-level management support for ITS/Operations, but little to no interest at top management levels. ITS/Operations not recognized as an agency priority.	Strong mid-level management support for ITS/Operations, with some interest/ involvement at top management levels.	Top level management support. ITS/Operations considered an agency priority within its overall mission.
Expectations	Not defined or limited to a lower category ITS project that's under consideration for deployment, expansion, or replacement.	Expectations exist for a few "special" ITS related projects. Expectations may or may not be realistic depending on if they've been managed properly.	ITS/Operations is part of both short and long range planning. Expectations are well defined with actual performance measures. ITS/Operations expectations focus on improvement and no on "status-quo."

- **Resources.** An agency needs many types of resources to achieve a successful ITS implementation. Personnel, funding, office space and equipment, and training represent just a few examples of these important resources. Obviously funding is important, but if funds are available, personnel resources are perhaps the most critical.

- **Management Support.** Upper management, including agency leadership, must buy-in to an ITS/operations philosophy in order for any ITS project to succeed. At the same time, intimate involvement in an ITS initiative by upper management may require changes in various aspects of a project implementation; hence the need for maintaining flexibility in procurement approaches.

- **Expectations.** This factor can make or break an ITS project. Managing expectations means not over promising, especially with regard to functionality or the time frame under which functionality will be deployed.

The worksheet in Appendix D has been developed to assist with determining Agency Capability Level.

TASK 4 -THE RELATIONSHIPS BETWEEN THE SELECTED PROCUREMENT APPROACH AND THE SYSTEMS ENGINEERING PROCESS

The application of systems engineering and project management principles to the acquisition of an intelligent transportation system will significantly increase the likelihood of a successful implementation. The contracting processes employed, to a large degree, determine the manner in which these principles are applied as well as the assignment of responsibilities for their application. In many respects the contracting processes used can have as much of an impact on the project's success as the statement-of-work and system specifications.

Systems Engineering Basics

A model has been developed by the systems engineering community that serves as the framework for defining a system life cycle. A system life cycle begins when the need for the system is conceived and ends when the system is discarded. The model includes a basic "V" shape along with wings to the left and right that are intended to represent a definition of the context within which the system is being developed, and the process for changes and upgrades respectively. The overall model is shown in Figure 5 (page25).

The left wing of the system lifecycle model represents the initial planning for the system. It defines the manner in which it fits into the technical and institutional context of the region, and is defined during the creation of the regional ITS Architecture. The key activities of this phase of the system life cycle are the identification of the regional stakeholders and establishing a consensus for the purpose of information sharing and long term operations and maintenance. Also included in the left wing of the model are the activities associated with establishing the feasibility of the project including a benefits analysis that defines the problem, the metrics by which the solution to the problem will be evaluated, establishes goals, and defines the benefit/cost analysis that will be used to justify the system and judge its success.

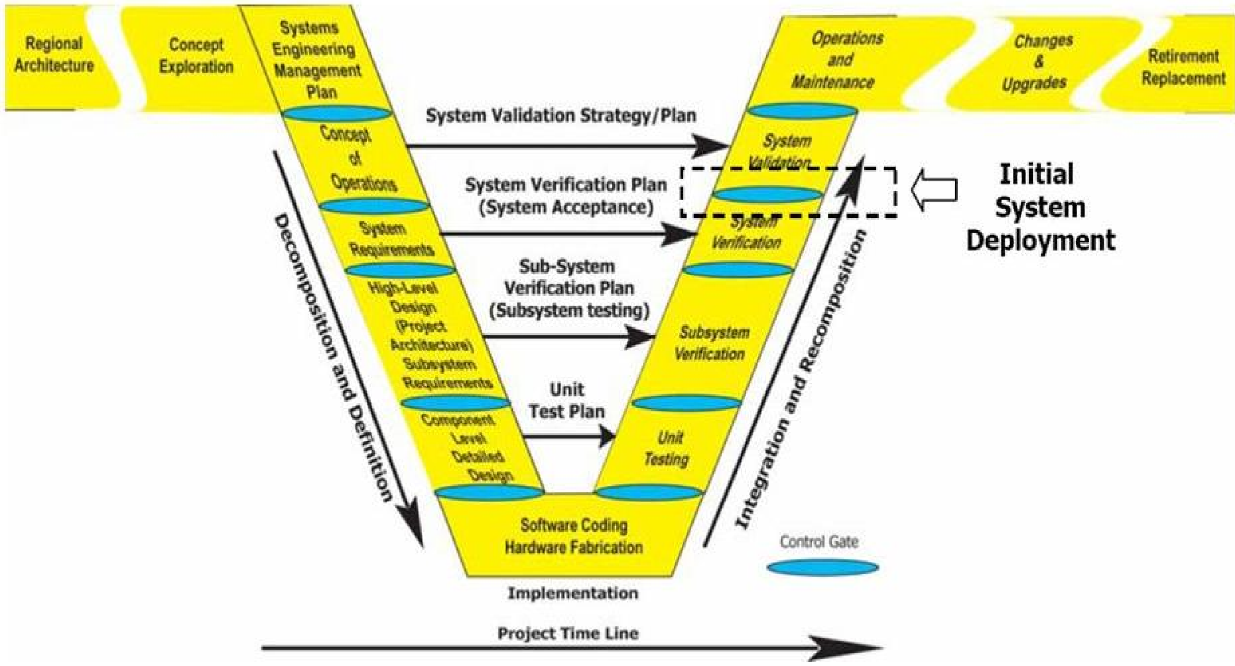

Figure 5 The "V" Lifecycle Model of Systems

The development of a specific system begins with the preparation of a systems engineering management plan and continues through the planning (represented by the concept of operations and shown on the left side of the "V"), through the system deployment and validation activities shown on the right side of the "V". The arrows on the outside of the "V" in Figure 5 (page 25) show the time sequence of these activities. In other words, the activities shown in the "V" also represent a progression in time when moving from the left side of the diagram to the right.

The systems engineering management plan includes a set of master plans and schedules that identifies the needed technical and project management information for the implementation of the project. These plans, along with the concept of operations become the control documents for the project implementation.

The "V" shape is used for the central part of the diagram to indicate the relationship between the planning, requirements and design activities on the left side of the "V", and the testing and validation activities on the right side of the "V". These relationships are indicated by the horizontal arrows in the diagram. Verification includes several sets of system testing beginning at the lowest level of unit testing, and proceeding to the highest level of verification identified as system verification testing (also known as acceptance testing). These tests are conducted to determine whether the "system was built right". The validation process, which is also shown as a horizontal line in Figure 5, is used to determine whether the system satisfies the needs of the organization and its stakeholders as defined by the Concept of Operations. In other words, validation is used to determine whether the "right system was built". As noted below, validation can also be considered an element of the right wing of the system, since it is performed on an on-going basis once the system is operational. In other words, the system must be continuously evaluated to ensure that it is continuing to meet the evolving the needs of the organization responsible for its operation.

In addition to validation, the right wing of the "V" includes the ongoing activities that occur following the acceptance of the completed system. These activities include operations and maintenance, the inevitable changes and upgrades associated with all high technology systems, and the ultimate retirement and/or replacement of the system. These activities are critically important, and must be subjected to the same systems engineering processes that were used during the system development. Plans must be developed for the system validation, as well as the operations and maintenance that define the metrics that will be used to determine the success or failure of these activities. Maintenance activities must include change control (including configuration management) contracting plans, and risk analysis. Contracting plans must be developed that define the resources that will be required to support these activities, and the staff and financial resources required for their successful execution.

Additional detail describing these steps can be found in Appendix G.

System Development Process Models

Systems engineering process models define alternative applications of the “V” diagram to the systems engineering process. The process model also determines the procurement approach being used for the system acquisition. Alternative system development processes include:

- Waterfall Model
- Evolutionary Model
- Spiral Model

Waterfall Model

As shown in Figure 6 (page 28), the waterfall model defines a linear process in which the steps of planning, designing and implementing (and their further subdivisions) are performed sequentially. Because of its linear nature, the waterfall process is relatively inflexible, and as a result, its use should be restricted to the implementation of well-defined systems. In actuality, the steps shown in Figure 6 are no more than the representation of a single pass through the steps of the “V” diagram of Figure 5 (page 25).

Spiral Model

The spiral model is intended for the acquisition of systems involving the development of new applications that are not well defined. For example, this model might have been used during the development of control centers for the automated highway system. It is characterized by a repetitive process of planning, requirements, design and prototyping. Prototypes are then evaluated to determine the degree to which they satisfy the initial vision and concepts of operation as shown in Figure 7 (page 28). It is an expensive model to implement, and for this reason its use should be limited to situations in which new technology and processes that have never been implemented before are being developed.

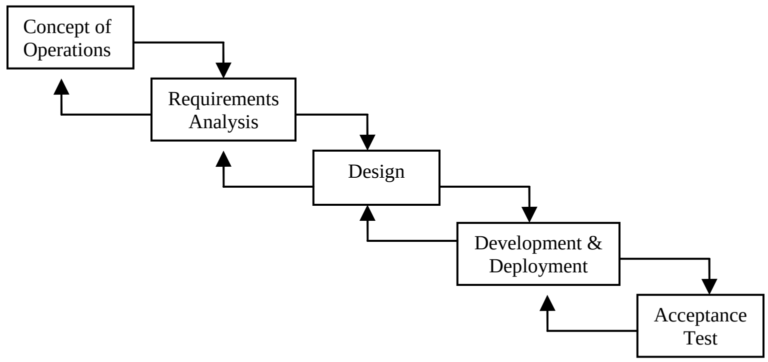

Figure 6. Waterfall Model of Systems Life Cycle

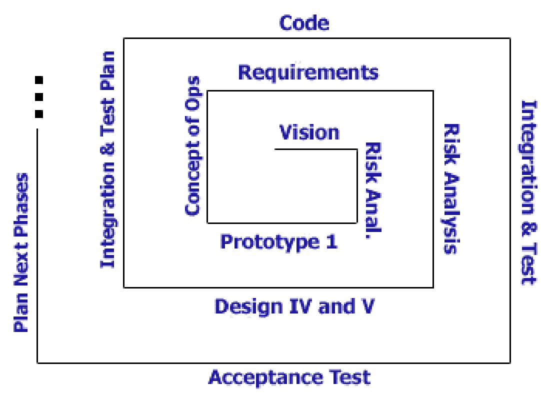

Figure 7. Spiral Model of Systems Life Cycle

Evolutionary Model

The Evolutionary Model is a formalized description of a phased system development. As its name implies, the evolutionary model defines a sequence of stages such that the system evolves through a sequence of versions, such that each version is closer to its final vision.

The evolutionary model can be described graphically as a linear sequence of "Vs" connected end-to-end. Figure 8 (page 30). It is recommended that the duration of these phases be from nine months to one year.

The evolutionary model has the benefits of "learning-by-doing", and for this reason, it minimizes the possibility of uncontrolled changes in requirements, and unanticipated cost or schedule overruns. It is applicable to most ITS system implementations

Cross-Cutting Systems Engineering Activities

A number of activities are conducted continuously during the system acquisition process including configuration management, risk management, validation and verification, and metrics, serve as the supporting framework for the system development. High-level descriptions of these activities are provided in Appendix G of this report. Many systems engineering references and courses exist that define these activities in greater detail.[6]

Project Management Considerations

It is also important to consider the general principles of project management that must be followed for a successful ITS project. In many respects, these principles are the basis for the steps that have been defined for the systems engineering process, and for this reason, they should be explicitly addressed when selecting the appropriate contracting activity. These principles have evolved from the recognition of the unique characteristics of software-based systems, which include the difficult (if not impossible) task of preparing definitive software specifications, the need to control changes in project scope (scope creep), and the challenging task of developing reliable cost and schedule estimates for the system development:

- **Collaboration –**A software-based project requires a close working relationship between the agency and the contractor to define the agency's needs and business processes, clarify uncertainties in the specifications, fully define all functions to be performed, modify the work as necessary to meet the needs of the users and stakeholders, etc.

[6] Sage, A.P. and Armstrong, J.E., "Introduction to Systems Engineering," Wiley and Sons, 2000.

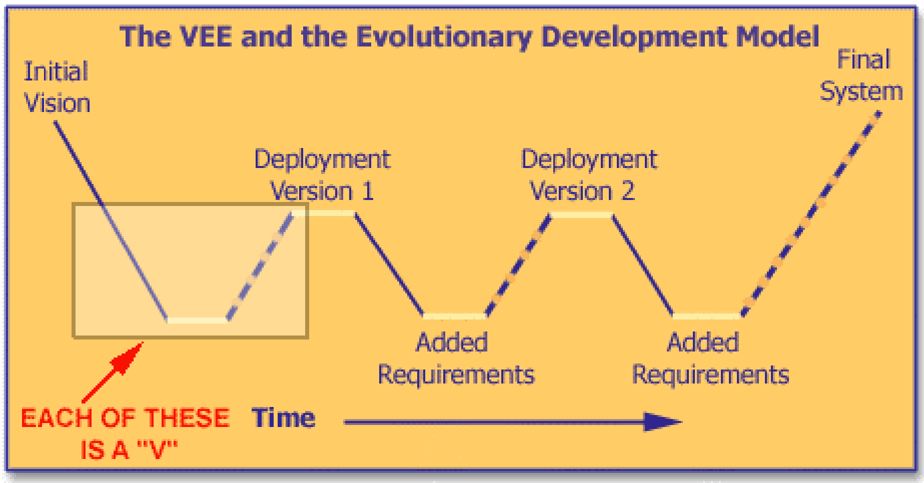

Figure 8. Evolutionary Model of Systems Life Cycle

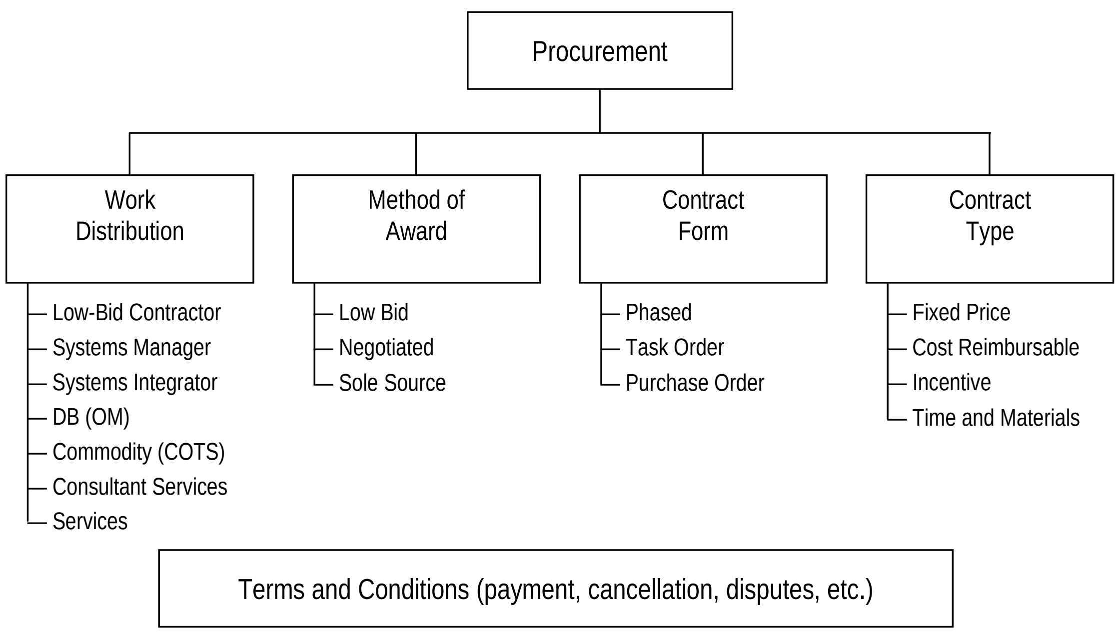

Figure 9. Contracting Framework

- **Off-the-shelf-solutions –** The use of commercial off-the-shelf (COTS) software offers a number of advantages over the development of unique software including the acquisition of a relatively mature (previously tested) package, the economic benefits of sharing the cost of upgrades with other agencies and the ability to acquire a package whose capabilities can be viewed prior to the initiation of system acquisition.

- **Prequalification/certification –** Many projects require offerors (bidders or proposers) to demonstrate that they are qualified to perform work on a planned project before their proposals (or bids) are evaluated. A recommended approach for prequalification is to require demonstration of knowledge and experience with the systems engineering process. This demonstration of systems engineering and development capabilities can be established by requiring the contractor's verification that its processes have been verified by an accredited organization. The appropriate certification for software development is known as the Capability Maturity Model (CMM)[7]. CMM levels 2 or 3 are generally adequate for ITS projects.
- **Organizational Considerations –** The two elements of an ITS project with the greatest development risk, and the most uncertain costs and schedules are the software and systems integration activities. Whenever possible during an ITS procurement, organizational structures should be required that permit the agency and the software developer/systems integrator to collaborate on the work, and make necessary adjustments as the work progresses. This can be most readily accomplished if the systems integrator (who is likely to be the software provider) is the prime contractor.

These considerations should be kept in mind when reviewing the contracting alternatives described in the following section.

Overview of Contracting

A framework has been developed to support the description and analysis of contracting alternatives analyzed during this research project. As indicated in Figure 9 (page 30)Figure 9, contracting activities have been defined in terms of four dimensions plus the terms and conditions, which are, in effect, a fifth contracting dimension.

Definitions of the terminology used in this section are provided in the Glossary.

Work Allocation

The work allocation category represents the project responsibilities defined by the agency for the contractor in the contract statement of work. These assignments are expressed in the systems engineering terminology – concept of operations, requirements, design, implementation and testing. They also include the crosscutting activities of configuration management, risk management, validation and verification, and metrics.

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7 For more information see: www.sei.cmu.edu/cmm/cmm.html

Low-Bid Contractor. This form of work allocation involves the selection of a contractor for system installation using the low-bid process. The contractor bids on a system design, typically prepared by a consultant. The consultant's responsibilities are included in the "Services" category of work allocation. The qualified contractor submitting the lowest bid, compliant with the specifications is selected to perform the work.

Systems Manager. The systems manager form of work allocation utilizes an organization known as the systems manager that has been selected using the negotiated method of award. The scope of work defined by a systems manager contract may include all project activities associated with a system acquisition except for the provision of equipment[8], electrical contracting and construction contracting. In other words, systems managers are operating under the constraints of consultant contracts, in that they can only participate in system implementation to the extent that personal services are being provided.

Systems Integrator. The role of the systems integrator is similar to that of the systems manager, except that the integrator is not involved in the planning and design stages.

Design-Build (DB) Contracting. DB contracting is based on an agreement "that provides for design and construction of improvements by a (single) contractor or private developer. Design-build contracts are typically preceded by the preparation of a partial design (sometimes designated a 30% design) prepared by a consultant. The design-build contractor is then responsible for completing the design as well as implementing the resulting system. This form of contracting is not allowed by some agencies.

Commodity (COTS). Contracting for the acquisition of commodities is applicable to ITS contracting to the extent that an agency is procuring commercial-off-the-shelf (COTS) products including both hardware and software. COTS procurements are quite different from consultant or low-bid contractor selections. The procurements are based on price and functionality of the COTS products.

Consultant Services. Work provided by consultants is limited to provision of personal services. Thus consultant services are a key element of a system acquisition when low-bid and design-build contractors are used for the system implementation. Consultant services are used not only for initial design, but also to supplement the development activities during the system implementation.

Outsource Contractor. Outsourcing is the process by which organizations (public or private) use external providers to manage or maintain certain aspects of their business. Outsourcing is increasingly used by the public sector in response to citizen's demands for expanded services and due to the difficulty of competing with the private sector for highly skilled personnel. Maintenance services are the most frequently used type of outsourcing in ITS. However, this form of contracting has also been used to provide system operations.

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[8] There are instances in which equipment can be furnished by the systems manager, subject to the interpretation of the agency's procurement organization. This is the case since the systems manager is only precluded from providing equipment and services that fall under the definition of construction (for projects using FHWA Federal-aid funds). As a result, many agencies permit the systems manager to furnish control center equipment such as operator workstations, large screen displays and communications routers.

Services. Contracts for other forms of services are frequently awarded during the life cycle of an ITS system. Technically, many of these other services may also be considered consulting services. The differentiation is made here to identify services that are outside the mainstream of system development. There are many forms of general services for which an agency may contract during an ITS life cycle.

Method of Award

The method of award category of contracting defines the criteria used and steps taken to select a contractor to perform the work. The method of award is determined by the form of work allocation that has been selected. As indicated below, there are distinct differences between the various methods of award. These differences should be taken into account when selecting a form of work allocation.

Low-Bid. Low-bid contracting commonly referred to as sealed bidding is a contracting method the employs competitive bids, public openings of bids and low price awards.

Negotiation. Unlike formal advertising of a contract requirement which is precise, highly structured method of procurement with one definitive set of procedures, negotiation allows considerable flexibility, permitting the use of a number of different procedures in making awards. The negotiated selection is typically based on the evaluation of a technical approach, qualifications and experience as represented in a technical proposal and possible subsequent presentations to the agency.

Best Value. Best value selection is most often used for the selection of design-build contractors. The best value selection combines the features of the negotiated and low-bid procurements. During the first step in this process, offerors (contractors) submit their proposed designs for evaluation and negotiation with the procuring agency. Following these negotiations, and the development of an acceptable design, the contractor submits a bid for the design that has been approved. Selection may be made based on the proposal that offers the best value to the procuring agency.

Sole Source. Sole source procurement is the direct selection of a contractor without competition.

Contract Form

The contract form defines the manner in which work is authorized. Three contract forms are defined, phased contracts, task order (or indefinite quantity) contracts, and purchase orders.

Phased Contracts. Phased contracts are the conventional form of contracting that is in use for the majority of projects including ITS acquisitions. Phased contracts divide the work into predefined activities. The contractor is authorized to begin work on a particular contract phase through the issuance of a simple letter by the agency.

Task Order (Indefinite-Delivery) Contracts. Indefinite-delivery contracts are used with contracts in which the required supplies and services are unknown at the time of contract execution. They provide a mechanism for the agency to place orders for these supplies and services during the life or term of the contract. In the case of ITS projects, the supplies and services requested are defined in terms of task orders that define the work to be performed by the contractor. Indefinite delivery contracts are ideally suited to both the evolutionary and spiral development processes, since they permit the issuance of task orders for additional planning, design and implementation services as various evolutionary phases evolve.

Purchase Orders. A purchase order is a form of sole-source contracting used for relatively small procurements. The cap on purchase order contract size varies among agencies, but is typically less than $50,000. Purchase orders are a simple, rapidly executed form of contract that usually contains a standard set of terms and conditions (payment, insurance, cancellation clauses, etc.) and a relatively brief description of the work to be performed.

Contract Type

Contract types define the manner in which contractors are reimbursed for their services. This includes the payment of incentives (or penalties) resulting from the contractor's performance.

Fixed Price Contracts. Fixed Price contracts place the risk and full responsibility for all costs and profit or loss on the contractor. After award, price under this type contract does not increase regardless of the costs incurred by the contractor during the performance of the contract. This type contract places the burden on the contractor to maintain control of costs and perform in the most effective and efficient manner.

Cost Reimbursement Contracts. Cost reimbursement contracts provide for payment of contractor costs, to the extent identified in the contract scope of work or specification. Cost reimbursement contracts establish an estimate of the total cost for the purpose of obligating not-to-exceed funds for the contractor (except at its own risk) without the approval of the procuring entity. The contractor's risk is implicit in the fact that a fixed fee will be paid independent of the actual cost of performing the work. Thus, while the contractor is guaranteed a profit (as opposed to fixed price contracts where the contractor can lose money), the profit measured as a percent of total cost can vary considerably.

Time and Materials Contracts. Time and materials contracts allow for procuring supplies or services on the basis of direct labor hours at agreed to fully burden fixed hourly rates and materials at cost, including material handling fees as a part of material costs. Time and material contracts are generally used when it is difficult to accurately estimate the extent and duration of the work to be performed by the contractor. This type contract places the majority of risk on the procuring entity requiring extreme care to ensure the proper level of contract monitoring and oversight is obtained.

Incentive Contracts. Incentive contracts are designed to motivate contractor efforts that might not otherwise be emphasized and discourage contractor inefficiency and waste. When predetermined formula-type incentives on technical performance or delivery are included, increases in profit or fee are provided only for the achievement that surpasses the targets, and decreases are provided to the extent that such targets are not met. The incentive increases or decreases are applied to performance targets rather than minimum performance requirements.

Performance-Based Contracting. Performance based contracting is a form of contractor incentive or disincentive, in that payments made based on the outcomes resulting from the system installation. Contracting today and in the foreseeable future will place special emphasis on what the agency wants performed by the contractor, (outcomes), versus the manner in which the work should be performed. In other words, more general work scopes, and more specifics on final system performance defined in measurable terms.

The importance of selecting the proper type and method of contracting for ITS procurements cannot be over stated. The primary concern for using innovative contracting approaches is the reduction in time and resources from project planning through construction and final acceptance and completion.

Relationship Between Contracting and Systems Engineering

The four components of the contracting framework are influenced by the work allocation, which in part, is determined by the systems engineering model, the system and agency characteristics. These relationships are summarized in Table 4 (page 36).

These considerations, along with the definition of Contracting Packages for each Work Allocation alternative were developed during Task 5.

TASK 5 – DEFINING THE OVERALL PLANNING AND CONTRACTING PROCESS

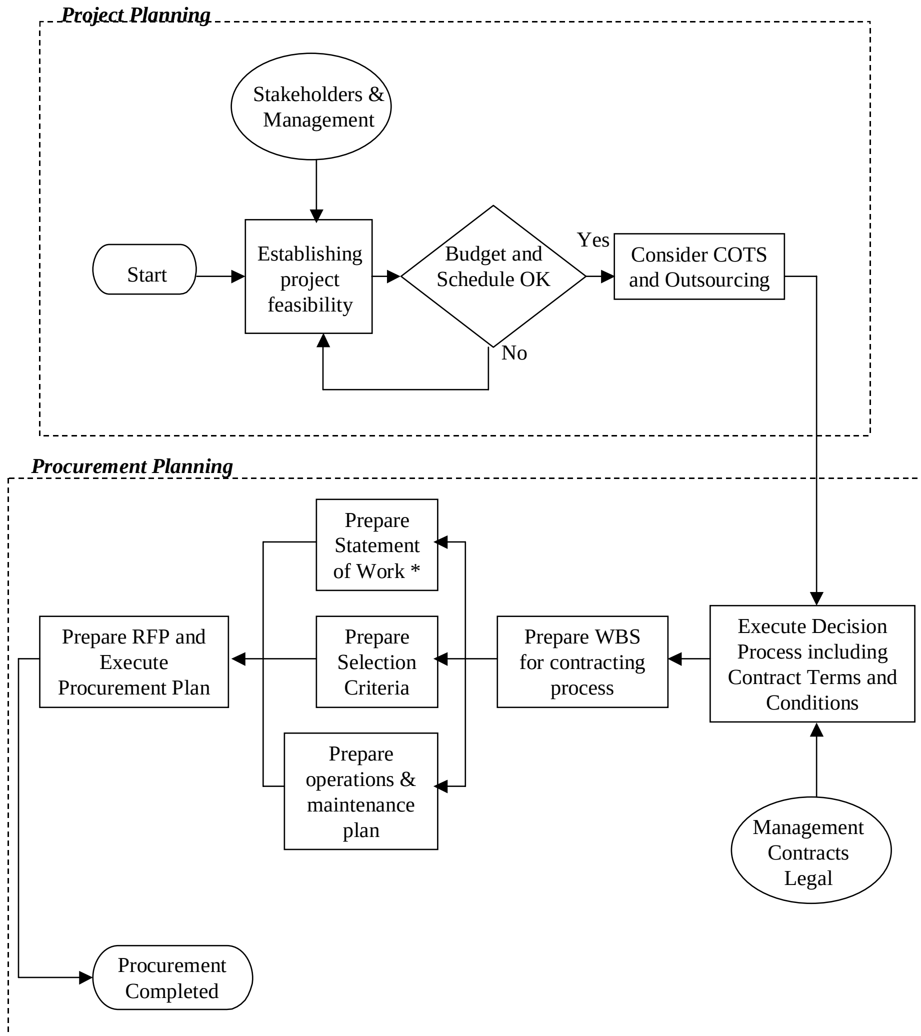
The objective of Task 5 is to describe the process of planning and executing a system procurement. However, procurement planning cannot be performed in isolation, and for this reason, the Task 5 activities also considered the initial planning activities that must precede procurement planning (designated project planning in this report). A decision model was also developed during Task 5 that serves as the basis for the guidelines produced as a separate product of this project. Additional details regarding the planning and procurement decision processes are provided in the guidelines and in Appendix J.

Project Planning

Project planning is performed to ensure that the procuring agency and its stakeholders "have their act together" and that their plans are compatible with the financial and personnel resources of the agency. As shown in Figure 10 (page 37), it is conducted prior to the initiation of a formal and expensive (at least to the contractor) procurement activity. It also addresses fundamental issues associated with the procurement regarding the use of COTS products and the possible use of outsourcing.

Table 4. Summary of Considerations in the Selection of Work Allocation

Work Allocation	**Key Considerations**		**General Comments**
	Systems Engineering	**Project Management**	
Consultant/Low-Bid Contractor	• Only applicable to waterfall model	• Eliminates possibility of collaboration and risk management	• Use should be restricted to well-defined systems
Systems Manager	• Used with any systems engineering model. • Single contractor responsible for planning, design, implementation, and testing	• Permits use of collaboration and risk management • Increased flexibility for use of contract form • Permits qualification-based selection	• Additional contracting burden placed on agency
Systems Integrator	• Used with any systems engineering model.	• Permits use of collaboration and risk management • Increased flexibility for use of contract form • Permits qualification-based selection	• Additional contracting burden placed on agency • Requires additional consulting assistance
Design-Build	• Most applicable to the waterfall model. • Possible to include other models, but their application would be the responsibility of the contractor.	• Only moderate collaboration and risk management possible.	• Most applicable to systems with time constraints and requirement for continuity between the design and implementation
Commodity (COTS)	For large systems, may be combined with one of the work allocation processes above (for example, the. COTS product is acquired in the same manner as any other system component.)		
Outsource Contractor	• Most applicable to the waterfall model.	• Only moderate levels of collaboration possible	• Difficult to define and measure outcomes
Services	N/A	N/A	N/A



* May also include plans and specifications as required by the selected contracting alternative

Figure 10. The Planning Process

Establishing Project Feasibility

The first step in the project planning process is establishing the feasibility of the project. This is not a trivial process. It involves establishing a team of stakeholders to develop an initial vision and to define initial project phases based on priority functionality. Constraints are also identified as well as a rough order of magnitude (ROM) cost, schedule, and resource estimates. Assuming project feasibility can be established in terms of its compatibility with available resources, project planning can be initiated. Project planning involves preparation of a project management plan and developing a procurement strategy consistent with an applicable system development process.

Establishing feasibility includes two steps; the development of a project scope, and determining whether the estimated cost and schedule for performing the work can be accommodated by the agency's available financial resources and time schedule requirements. If this process concludes that the project costs exceed the agency's budget capabilities, or the schedule is too long, it will be necessary to reduce the project scope. There is no other solution to this problem.

Other Considerations

Once an acceptable project scope has been established, it is necessary to consider other fundamental approaches to the system development. Two of the most important considerations to be included in this step are the need for the development of a unique system vs. the purchase of a COTS solution, and the possible use of outsourcing. Both of these procurement approaches were discussed in the summary of Task 4 activities and in Appendix G. Decisions regarding COTS should be based on a critical comparison of needs with the features of available systems. If a good match can be achieved, COTS-type procurement should be considered. A project is a candidate for outsourcing if an agency concludes that it does not have either the personnel or experience to manage the system acquisition.

Procurement Planning

Once the initial project planning has been completed, procurement planning can be initiated as shown in the lower half of Figure 10 (page 37). Procurement planning identifies all the actions that must be considered for a successful ITS acquisition and contract award. The procurement plan will allow coordination and sequencing of actions throughout the contracting process. The complexity of a project can have a significant impact on the selection of a procurement strategy. ITS projects can range in complexity from those that are relatively straightforward as in adding field devices (e.g., CCTV, DMS, etc.) to an existing traffic management system, to those that are extremely complex such as the implementation of a completely new transportation management system. The procurement strategy for these two undertakings would be significantly different.

The procurement strategy must also take the agency's resources and capabilities into account. It must also consider the environment in which the project will be planned, designed, deployed, and operated.   Addressing these issues is an important part of developing a procurement strategy.

Another important consideration is whether or not a project should be implemented using more than one contract. Not all contracts associated with a project require the same contracting approach. The magnitude of a project may involve a mix of complexity and incompatible services (e.g. construction, custom software development, systems integration, operations and maintenance) that diminishes the possibility for implementation success under a single contractor.

The Decision Model

The following considerations set the stage for the Decision Model, which is based on the two dimensions of system engineering process and agency experience/environment.

- Systems engineering process has major influence on contracting approach.
- Defining the project complexity and agency characteristics, permit selection of the appropriate contracting approach.
- In actuality, there are four basic contracting processes (defined as packages here). The other contracting dimensions are adjustments to these processes.
- Contract terms and conditions are an important element of the contracting process. They are defined once a package has been selected.

The Basic Model (Structure and Packages): The four dimensions of procurement described earlier provide a structured representation of the contracting process (procurement). The purpose of the selection is to identify the combination of items (one from each of the four dimensions) that are most appropriate for the project characteristics and the agency's capabilities.

Early in the development of this process, it was recognized that there are only a few unique combinations of these items (designated work packages). These packages are the fundamental output of the selection process. Contract terms and conditions are selected as a separate step. The package numbers shown in Table 5 (page 40) are referenced in the initial steps of the decision process. Generally, packages 1 through 4 are used for traditional system implementation, although they can obviously be used for other purposes. Package 5 is either a supporting function for the system implementation, or may be used for numerous other consultant activities. Packages 6 and 7 are used for the provision of activities (an internal agency process such as inspection, maintenance, operations, mowing, or signal timing) and functions (an entire agency service such as traffic management, traveler information or toll collection) in a manner that reduces the agencies staffing requirements. Packages have not been defined for the "other" category of the work allocation dimension.

Table 5. Procurement Packages

Package No.	Work Allocation (Package Name)	Method of Award	Contract Form	Contract Type	Comments
1	Commodity Supplier	Low-bid selection of prequalified packages	Single phase or purchase order	Fixed Price	Used for COTS procurements
2	Low-Bid Contractor with Consultant Design	Low-bid for contractor	Phased orTask Order	Fixed Price for contractor incentives optional	Consultant performs 100% of design. May provide additional services during implementation
3	Systems Manager	Quality-based selection (negotiated procurement)	Phased or Task Order	Fixed price, cost plus or time & materials incentives optional	Field equipment procured by agency using low-bid process
4	Design-Build Contractor with Design Consultant	Best-value selection (based on consideration of price and quality)	Phased	Usually fixed price, cost plus or time & materials incentives optional	Consultant provides 30% design.
5	Consultant	Negotiated	Phased or Task Order	Fixed price, cost plus or time & materials incentives optional	Used for system design and many other consultant services
6	Outsourcing Agency Activity	Low-bid may be based on rates	Usually single phase	Fixed price or time & materials incentives optional	Typical activities include maintenance, operations, signal timing, etc.)
7	Outsourcing Agency Function	Best value or low-bid	Single phase	Fixed price, cost plus or time & material contracts Incentives optional	Typical functions include traveler information and toll collection. May be public-private partnership

The following process is presented as a sequence of steps that must be followed to arrive at the selection of a work package, followed by the identification of appropriate terms and conditions. The steps of the selection process are described in detail in the Guidelines and in Appendix J.

Step 1 - The first step in the decision process is to identify the fundamental project characteristics that differentiate between a system development, a consultant contract and an outsourcing contract. These differences were determined during the project planning activities described earlier. This logic is formalized in Figure 11 (page 42), which leads directly to the identification of an appropriate procurement package or guides the user to the more complex steps required for system development. If a procurement package is directly selected, the user can proceed directly to Step 7 (consultation with procurement officials). The process that should be followed for the execution of the remainder of the decision process is shown in Figure 12 (page 42).

Step 2 - The second step (Step 2) in the process determines whether the acquisition should be performed as a single project or multiple projects. It is shown as one of the initial activities the decision model, since the model must individually consider each of the individual projects resulting from this decision. In other words, it is not necessary that each project be executed using the same contracting process. This is particularly true when the nature of the work in each contract is different. For example, one project may include the central system (including software) implementation, while another project might consist only of field installations.

Step 3 - The third step of the process (Step 3) is the definition of project categories. This step relies on the work performed during Task 3 of this NCHRP project (see Table 2 on page 20) that identified categories of project difficulty using the characteristics of the work to be performed. During Step 3, Table 2 is used to determine whether the project is a Category 1, 2, 3 or 4 project.

Step 4 - The fourth step involves a determination of the agency's capability level. This step uses the information in Table 3 (page 23) to determine the level that best suits the agency managing the system acquisition. In essence, this step is used to assess the agency's organization, experiences and resources relative to ITS procurements.

Step 5 - Step 5 is one of the key steps of the process in that it is used to identify the appropriate contracting and systems engineering processes for the project being initiated. To execute this step, it is important to understand the alternative systems engineering processes described in Task 4. The alternative processes (also known as models) include the Waterfall Model, the Evolutionary Model, and the Spiral Model.

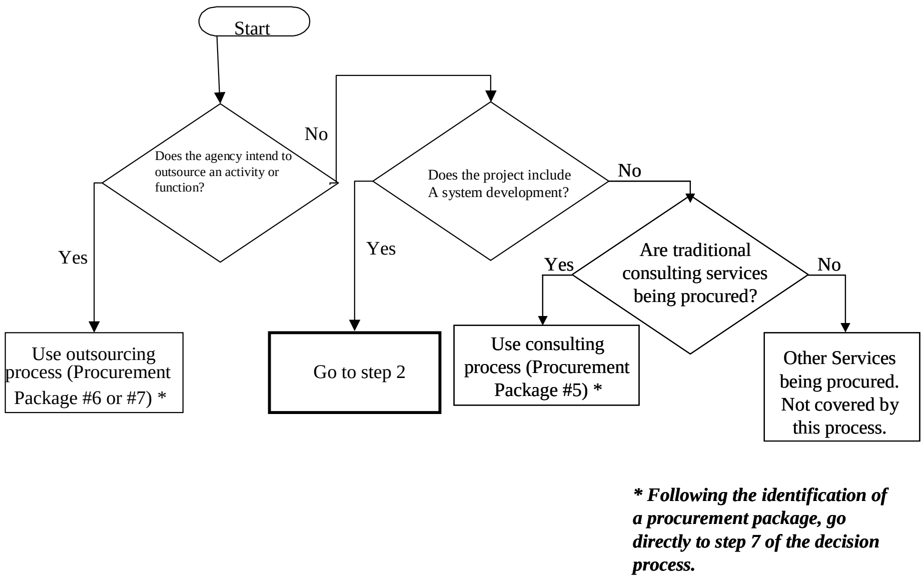


Figure 11. Initial Decisions – Step 1

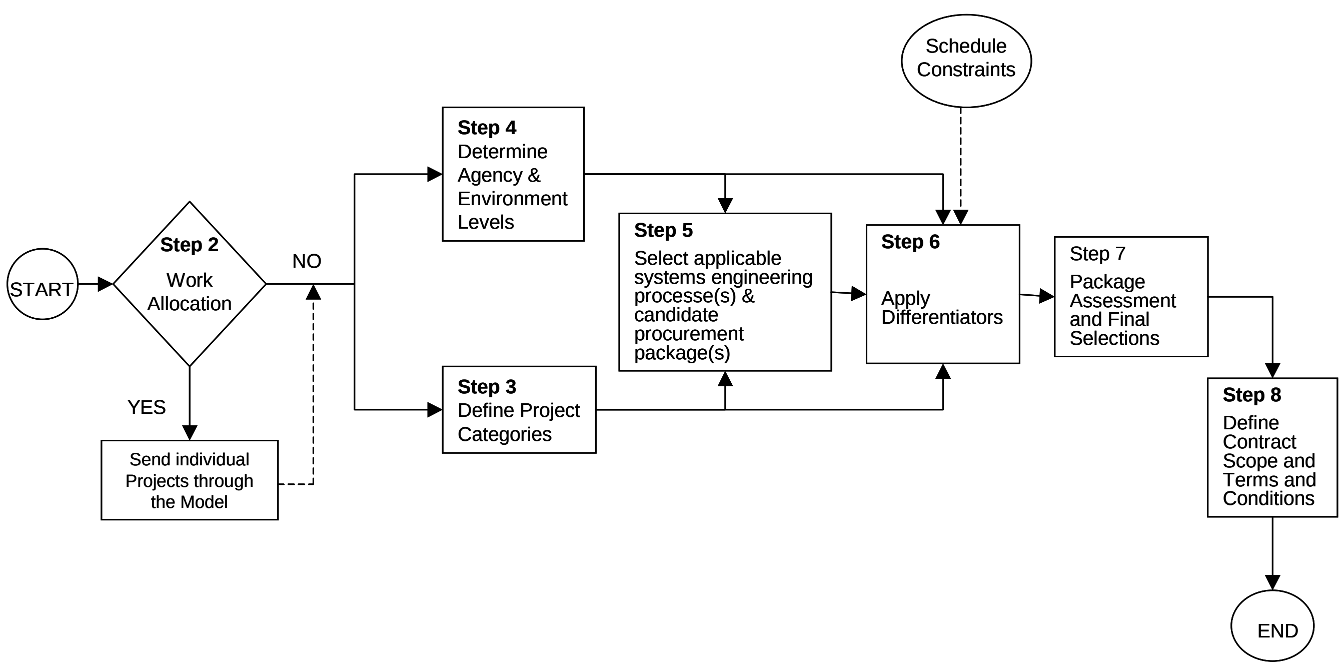


Figure 12. The Decision Model – Steps 2 through 8

The decision matrix shown in Table 6 (page 44) is used as the basis for this step. To use this matrix, it is necessary for the agency to have identified its project category, and its organizational level of capability. The agency then identifies the columns and rows of the matrix that match this combination of capabilities and levels. The intersection of the applicable column and row identifies the cell that defines the procurement package or packages that should be used.

The COTS entries reflect the fact that a simple system, based entirely on a COTS product should be acquired using the commodity procurement package. When COTS products are part of a larger system, other procurement packages may be used (i.e. the product may be part of a proposal for low-bid, systems manager, or design-build procurements). A design-build contractor or a systems manager may decide to acquire a COTS product during the system implementation. If this is the case, the product should be acquired by the contractor using a commodity procurement package.

Step 6 is provided to assist in the selection of a specific approach, when multiple packages are recommended.

Step 6 - The next step in the process, Step 6, is to be used when more than one procurement package type is identified as acceptable during Step 5. It provides some additional criteria to help reduce the number of alternatives. These criteria are listed below:

- Systems manager is preferred to design-build when significant amount of new software development required.

- Design-build is preferred over systems manager only for major projects when significant amounts of field construction are involved and there is a desire to reduce implementation delays associated with having to administer multiple procurement contracts.

- The evolutionary systems engineering model is preferred over the spiral model because it is less costly and easier to apply. The spiral model should only be used in the event that complex new developments are required.

- If a project includes both new software and field construction, consider splitting it into multiple contracts.

- Low-bid contracting should only be used if required by agency policy, and/or projects are limited to field construction and supply of off-the-shelf equipment.

- Commodity procurement is only applicable if an existing package is available that does not require any modification to meet agency's requirements except for:

    - New drivers for interface with communications and field equipment,
    - New database reflecting system configuration, and
    - New map graphics.

Table 6. The Decision Matrix – Step 5

Project Category	*Agency Capability Level*		
	Level 1	*Level 2*	*Level 3*
1 – Low	• ***Waterfall*** • SM*	• ***Waterfall*** • Low Bid*, commodity, or SM	• ***Waterfall*** • Low Bid, commodity, or SM
2 – Moderately Complex	• ***Evolutionary*** • SM or DB*	• ***Waterfall or evolutionary*** • Low Bid*, SM or DB	• ***Waterfall or evolutionary*** • Low Bid, SM or DB
3 – Complex	***Not recommended***	• ***Evolutionary*** • SM or DB	• ***Evolutionary or spiral*** • SM or DB
4 – Extremely Complex	***Not recommended***	• ***Evolutionary or spiral*** • SM or DB	• ***Evolutionary or spiral*** • SM or DB

Notes:

First line is the systems engineering technique; second line is the procurement package
DB = Design Build
SM = Systems Manager
* - Consulting services should be used while project is underway

If after considering these differentiators, multiple solutions still remain, the preferred alternative should be chosen based on the preferences of the agency's procurement officials (See Step 7).

Step 7 - Step 7 is a critical step for all procurements. If it has not been done already, at this point it is imperative to discuss decisions made to this point with agency procurement personnel. It may also be desirable to include legal personnel to discuss intellectual property rights, which must be considered during the preparation of terms and conditions in Step 7. Procurement officials must also participate in the selection between multiple options.

Step 8 - The final step in the decision process is the selection of the necessary terms and conditions to be included in the contract. Some terms and conditions are required for all types of contracts. Others are only suitable for certain types of contracts (i.e., commodity supplier, low bid with design consultant, system manager, and design-build contractor).

Statement of Work

Following the selection of a contracting approach along with its associated terms and conditions, it is possible to continue the contract planning activities including the identification of the activities to be performed, preparation of a schedule, and a contract statement of work. In addition, the contracting process must be defined including prequalification requirements, evaluation criteria, and the members of the contractor selection panel. The contract statement of work (SOW) must include all of the significant systems engineering activities required for a successful project execution as well as reporting requirements, deliverables, schedules, and the responsibilities of both the contractor and the agency. If a task order contract is anticipated, the statement of work must also define the mechanics of the task order process. Perhaps most important, the SOW should define requirements for ongoing support as well as the anticipated requirement for maintenance services to be provided by the contractor following system acceptance. Procurement planning should also take into account the agency resources required during the system acquisition including both personnel and facilities.

Decision Model Testing

The five projects shown in Table 7 (page 46) were selected to test the procurement model. The table shows the procurement strategies that the decision model recommended for each project. The testing concluded that the recommendations of the decision model are appropriate and are comparable to the ones previously used for the projects. Since these projects are all, generally considered to have been successful, the model is considered to have passed these preliminary tests.

Table 7. Decision Model Test Results

ITS Project Description	System Type	Project Cat.	Org. Level	Model Recommendation: System Development Process	Model Recommendation: Procurement Packages	Procurement Strategy Used
TRANSMIT: Install additional transp. readers on Belt Parkway, Van Wyk, Cross Island, etc	FMS Software Development	1	2	Waterfall	SM for software development	Work Allocation: DB / Method of Award: Negotiated / Contract Form: Phased / Contract Type: Fixed Price
	FMS Field Installation	1	2	Waterfall	DB for field installation	
Expand FMS/EOC in Baton Rouge, LA	FMS	2	1	Evolutionary	DB preferred over SM because significant amount of field construction is required. Can use Design Consultant and DB Contractor	Work Allocation: SM / Method of Award: Negotiated / Contract Form: Phased / Contract Type: Fixed Price
Maintain ITS Equipment in Virginia I-81 Corridor	O&M	2	1	N/A	Other Services being procured. Skips steps 1-4 from decision model. Outsourcing an agency activity: Low-bid selection may be based on rates. Fixed price or time & material contracts. Can use incentives such as performance-based contracting	Work Allocation: Services / Method of Award: Negotiated / Contract Form: Task Order / Contract Type : Incentive
Integrate operations of fixed-route and demand-response paratransit systems in Brownsville, TX	TMS	3	2	Evolutionary	Low Bid. Requires design consultant & low bid contractor	Work Allocation: SM / Method of Award: Negotiated / Contract Form: Phased / Contract Type : Fixed Price
Capital Wireless Integrated Network (CapWin) Project	PS	4	3	Evolutionary or Spiral	SM for software development; Low bid contractor for field construction and field equipment supply	Work Allocation: SM / Method of Award: Negotiated / Contract Form: Task Order / Contract Type : Fixed Price and T&M

FMS = Freeway Management System
TMS = Transit Management System
ETC = Electronic Toll Collection
PS = Public Safetv
O&M = Operations & Maintenance

SM = System Manager
DB = Design Build
T&M = Time and Materials

CHAPTER III
INTERPRETATION, APPRAISAL AND APPLICATIONS

This section summarizes and interprets the findings of the research relative to the procurement and subsequent acquisition of intelligent transportation systems. Since the primary objective of the study was the development of procurement guidelines, this information focuses on the background and techniques associated with the development of a process that can be used by agencies for the selection of the best procurement approach.

Innovation in procurement primarily exists in the areas of incentive-based contracting. Contracting processes are constrained by state policies and procedures. This leaves very little latitude for experimenting with new contracting approaches. In spite of this constraint, some agencies are considering various types of incentive-based contracting in which payment terms are directly linked to contractor performance. Traditionally, incentive-based contracting has focused on delivery of products ahead of schedule. New techniques are being explored in which incentives are based on the impact of the new system on traffic flow or other measures that reflect the effectiveness of the new system. Care must be taken when defining these measures to ensure that they are achievable and measurable, in a dynamic environment with changing traffic demand. Because of the unproven nature of incentive-based contracting for ITS, as well as its potential complexities, it was described but not recommended as an alternative for the contracting process.

Design-build contracting is receiving widespread acceptance for construction projects, but must be applied cautiously to ITS projects. Design-build contracting is becoming a popular method for reducing the time required for highway construction and other civil sector projects. It involves the preparation of a 30% design that is used as the basis for the best-value selection of a design-build contractor. Its applicability to ITS is limited to large projects that typically include significant field construction. However, the requirement for an initial 30% design precludes the design-build contractor from participating in the initial planning and requirements definition stages of the project. For these reasons, design-build contracting was recommended for projects involving field construction. Projects requiring complex software development for which design-build contracting is being considered, should either be divided into multiple contracts, or an alternative form of contracting should be used.

The type of procurement selected for ITS projects is dependent both on the nature of the project as well as the organization and experience levels of the procuring agency. The survey of existing practices concluded that agencies tend to use a single contracting approach for all ITS projects based on past experience as well as existing agency policies. However, a review of sample projects demonstrated the importance of considering both the agency's experience as well as the complexity of the project prior to the selection of a procurement approach. Differing procurement approaches provide varying degrees of contractor support and permit the use of differing systems development methodologies. A matrix was developed that described the important agency capabilities. This matrix along with a companion matrix that defined alternative system characteristics are used for the selection of procurement and systems engineering approaches to be used for the project procurement and implementation.

The risks associated with an ITS procurement are reduced if stovepiping is eliminated. (Stovepiping is an approach in which responsibility for planning, design, implementation and operation resides in separate organizational units.) The successful implementation of a system requires a fully integrated team (including the contractor) that can work together in a collaborative fashion to ensure that requirements reflect the agency's business process. An integrated team will also ensure that the system design reflects the requirements, and that the implementation reflects the design. It is difficult (if not impossible) to accurately define requirements and specifications for a system without continuing interaction among the stakeholders (users) of the system, its planners, designers and implementers. For this reason, the guidelines give preferential treatment to contracting approaches that provide for collaborative interaction among members of the system development team. Research conducted on this project did not directly consider the number of agencies in which stovepiping occurs, nor did it attempt to quantify the impacts of this type of organization. Additional research in this area has been recommended.

The systems engineering model (waterfall, evolutionary, spiral) used for the system implementation influences the type of procurement used. A review of systems engineering technology identified three fundamental types of system development, each of which is appropriate for specific types of projects. The waterfall approach is most appropriate for acquisitions of well-defined mature technology. The evolutionary approach is appropriate for large scale system procurements involving new software development. The spiral method is appropriate when new technological capabilities are being implemented. Not all systems engineering methodologies can be implemented using the same procurement approaches. This is reflected in the procurement guidelines, which combine the recommended procurement approach to the systems engineering methodology that should be used.

ITS procurement can be divided into seven basic types (denoted packages in the guidelines) which embody the contractor's responsibilities, selection process, payment terms, and contract form. Analysis of the procurement process led to the development of a four dimensional model that included work distribution (who does what), method of award (how contractors are selected), contract form (phased, task order, etc.), and payment terms (fixed price, cost reimbursable, incentive, time and materials). At first, it appeared that there were an infeasible number of possible combinations of these four dimensions. However, upon further analysis, it was found that many of these combinations are incompatible with each other. As a result, seven fundamental types of procurement packages were defined which serve as the fundamental output of the selection procedures contained in the guidelines.

When considering procurement alternatives it is important to consider the possibility of using commercial-off-the-shelf (COTS) products for ITS implementation. The review of existing practices concluded that few agencies emphasize the procurement of off COTS products when acquiring a new system. There were some exceptions, such as the procurement of a traffic management system by the Utah Department of Transportation. However, even in this case, significant work was required to adapt the system to the agency's requirements. This is somewhat at odds with practices of agencies outside of the transportation community, in which COTS procurements are being increasingly emphasized, due to the higher levels of maturity and lower cost associated with these systems. For this reason, the acquisition of COTS products through a commodity type procurement process has been included as an alternative in the procurement selection process.

Some states are using outsourcing as an alternative to conventional procurement practices for acquisition of new systems or capabilities. The research concluded that outsourcing is a useful approach for the acquisition of new systems when the agency requires a new capability but does not have the personnel resources to manage its implementation, operations and maintenance. When this approach is used, the agency contracts for the acquisition of a function (or capability) rather than a specific system. There is increasing interest in this approach as a result of the shortage of skilled individuals capable of managing the acquisition, operations and maintenance of a complex system. As a result, outsourcing is included as a procurement alternative.

Low-bid procurement is applicable only to extremely well-defined projects. Analysis of the systems engineering requirements of ITS procurements identified collaboration between contractor and agency personnel, participation in the planning process, flexibility in definition of functions and iterative system developments as key features of a successful project implementation. It is difficult, if not impossible, to incorporate these activities into a low-bid procurement. For this reason, the guidelines recommend that low-bid procurements only be used for acquisition of systems with well-defined capabilities by agencies with the experience to manage its implementation.

It is essential that projects be structured in a manner that provides direct access to the contractor performing the high risk portions of the work. This may lead to the need for multiple contracts. The organization of the contractor's team has been shown to be one of the shortcomings of projects that have experienced difficulties. It was concluded that one of the ingredients of a successful project is the ability of the agency's project engineer to interact directly with the contractor whose work represents the highest risk to the project's success (i.e. the system software). It was concluded that projects requiring extensive software development, must be organized such that the contractor responsible for the software development is the prime contractor. In the event that the overall project requirements prevent this form of organization under a single contract (i.e. the software has a low dollar value relative to the overall contract), the guidelines suggest that the project be divided into multiple contracts. The software developer should be the prime contractor for one of these contracts.

Project planning is a frequently overlooked step in the system development process. Project planning encompasses a number of activities that are critical to the system procurement and acquisition process. Yet these activities are rarely (if ever) performed. The research concluded that all procurements should be preceded by the definition of project scope, a careful cost estimating process, and the development of a work breakdown structure with schedule for the system procurement. These activities should be documented in a procurement plan, and a project management plan that can be used as the basis for the system acquisition.

The contracting statement of work must ensure that responsibilities for performing all systems engineering activities are fully identified. The definition of the systems engineering process prepared for this research identified a number of cross-cutting activities that are critical to the overall success of the system acquisition. These activities include: risk management, configuration management (including the establishment of a configuration control board) and quality assurance. Responsibility for these "cross-cutting" activities should be defined in the contractor's scope of work. They are described in the guidelines.

CHAPTER IV
CONCLUSIONS AND SUGGESTED RESEARCH

ENCOURAGE USE OF GUIDELINES AND DISSEMINATE THE RESULTS

The guidelines prepared for this project represent a breakthrough in the ITS community's understanding of the interrelationship among organizational experience and resources, project characteristics and procurement techniques. It is unlikely that any new techniques and procedures will be integrated into the accepted practices of the profession unless their use is actively encouraged. For this reason, it is recommended that an aggressive outreach campaign be developed and executed with the support of the American Association of State Highway and Transportation Officials (AASHTO), ITS America, and the National Transportation Operations Coalition (NTOC) that includes:

- Preparation and dissemination of brochures and other announcements intended to inform the profession of the availability of this research and the potential benefits of its use
- Preparation and delivery of training courses (either on-line or classroom) to instruct ITS professionals on the use of the guidelines
- Integration of the guidelines into existing curricula of the Federal Highway Administration's Professional Capacity Building Program including existing systems engineering and project management courses. Training should also be provided to FHWA field personnel regarding the availability of the guidelines and their application to the ITS procurement process.
- Inclusion of papers and presentations describing this work at national conferences sponsored by ITS America, the Institute of Transportation Engineers and NTOC.
- Offers of assistance through the FHWA Peer-to-Peer program, to agencies contemplating ITS procurements. This requires provision of prior training to Peer-to-Peer personnel in the use of the guidelines.

PILOT TEST GUIDELINES

Testing of the guidelines should be conducted, using a sample of upcoming ITS procurements. Testing should be performed for a variety of procurements including systems development and outsourcing, small systems and large systems, field construction and central system installations. The testing should include documentation of the processes used, the conclusion of the process and the success of the system implementation.

RESEARCH IMPACT OF ORGANIZATIONAL STRUCTURES ON ITS PROCUREMENT

During the research it became evident that organization structure can have a significant impact on the success of the ITS system procurement as well as the overall implementation process. Organizations in which the functions of planning, engineering (design), construction, operations and maintenance are integrated tend to have a better record of success, than organizations in which these functions have been segregated into independent units (stovepiped). More information on the relationship between organization and system development risk is required. It is necessary to identify the range of organizations that currently exist within State DOTs, and evaluate their relative success in the system acquisition process. It is recommended that research be conducted in this area.

INTEGRATE GUIDELINES INTO SYSTEMS ENGINEERING PROCESSES

Predictably, this project concluded that the procurement and systems engineering process are interdependent on each other. One of the conclusions of this project that the combination of agency and project characteristics could be used, not only to define the procurement approach, but to identify the most suitable systems engineering process. These results should be integrated into the systems engineering training material and other reports used by the ITS community for systems implementation.

GLOSSARY OF TERMS

Acquisition	The overall process of implementing a system, including planning, procurement, design, development, testing and acceptance.
Best Value	A form of contractor selection based on both the quality of the contract and cost.
Burden	A percentage charge applied to the direct contract costs that cover the contractor's cost of doing business. Typical burden items include overhead (rent, office supplies, business expenses, office equipment, legal expenses, etc.), fringes (employee benefits - including sick leave, vacation, health insurance, etc.), general and administrative costs (management costs).
Certification	The formal acknowledgement (usually provided by an independent organization) that a contractor has certain capabilities and procedures required for a particular purpose. Certification may be required as part of a pre-qualification process.
Collaboration	A close working relationship between the customer and the supplier that permits the exchange of ideas and joint resolution of problems associated with a project.
Commodity	A commodity is a product as distinguished from a service
Commodity Supplier	A supplier from which commercial off-the-shelf products (including software) are being purchased.
Consultant	A contractor whose work is limited to personal services. Consultants do not supply construction services and/or equipment.
Contract	A written agreement between two parties (in this case it is assumed that the parties will be the agency and an outside organization – usually a private sector firm) that is an agreement for doing or not doing something that is specified.
Contract Form	As used in these guidelines, the manner in which work is authorized during the contract period of performance.
Contract Type	As used in these guidelines, the manner in which contractors are reimbursed for their work.
Contracting	The selection of a firm to provide a set of services or products, as well as negotiating and executing a contract.

Contractor	This term is used in two different ways. The general use of this term is that the contractor is an organization with which a contract has been signed. This general terminology can include a design contractor (consultant), software company, systems integrator, electrical contractor, construction contractor, etc. When the Consultant/Contractor form of work allocation is discussed, the term contractor is a reference to an organization that has been selected (usually on a low-bid basis) to implement a system specified by a consultant. To avoid confusion in the discussion of this form of work allocation, the organization selected in this manner will be referred to as a low-bid contractor.
Cost Reimbursable	A form of reimbursement in which the contractors are paid the actual cost of performing the work, plus a fee that may be a fixed amount, or may be adjusted based on the quality of the contractor's performance.
Design-Build Contract	A form of contract in which the contractor is given responsibility for both the system design as well as its implementation
Design-Build Operate and Maintain	A design-build contractor (see definition) who has also been given responsibility for operations and maintenance once the system development has been completed.
Direct Costs	Expenses directly attributable to work performed on a project, as opposed to indirect costs, which are unrelated to specific projects.
Evolutionary Model	A systems engineering methodology in which the system is implemented incrementally. The steps of design, development and testing are repeated for each incremental "build".
Fee	Synonymous with Profit. The fee (or profit) is the payments received by the contractor in excess of contract costs and burdens that are value-added compensation for performing the work.
Fixed Price	A form of reimbursement in which the contractors are paid a fixed amount, independent of the actual costs of performing the work, based on an initial cost estimate
Incentive	An additional fee paid to the contractor based on pre-defined criteria
Indirect Costs	Expenses of doing business that cannot be directly attributable to a specific project. Examples of indirect costs include office space, advertising, employee fringe benefits, etc.
Invitation for Bids	A document released by a procuring agency requesting bids for services, equipment and/or commodities from potential contractors. A contract is awarded to the lowest responsive and responsible bidder.
Invitation to Negotiate	A contractor selection process that includes a series of steps in which work scope is adjusted based on vendors proposals.

Low-Bid	The process of competing for work defined by a set of plans and specifications based exclusively on bid price. The competitor with the lowest bid price is selected for the project.
Method of Award	As used in these guidelines, the process by which a contractor is selected during a competitive procurement
Negotiated Procurement	A process by which all procurement terms are discussed and may be reconsidered by the purchaser and the offeror. These terms may include requirements, specifications, period of performance, location of work, scope of services, staffing requirements, etc. Negotiated procurements typically reflect a discussion of non-financial considerations prior to the discussion of the proposed contract cost although this "two step" evaluation is not always required.
Negotiated Selection	A selection process in which a contractor (usually a consultant or systems manager) is selected based on the quality of a proposal which describes the contractor's capabilities, staff skills, technical approach and prior experience. Negotiated selections usually do not include consideration of cost.
Outsourcing	A form of contract in which the contractor's responsibilities are defined based on managing or maintaining certain aspects of an agencies' business.
Performance-Based Contracting	A contracting process in which the contractor's compensation for work on the contract is partially dependent on the success of the project.
Phased	A contract in which work is divided into stages. Typically each stage cannot begin without prior authorization of the agency.
Pre-Qualification	The process of assessing a contractor's ability to perform the required work based on past experience and staff skills. Pre-Qualification is often a step that precedes the proposing or bidding process of procurement, and must be satisfied by the contractors in order for them to participate in the process.
Procurement	The process of selecting a contractor and negotiating a contract for delivery of a services and/or products. Procurement is a subset of the system acquisition process. Same as contracting
Purchase Order	An offer by the procuring agency to buy supplies or services, including construction and research and development, using specified terms and conditions.

Request for Proposals	A document released by a procuring agency asking for the submission of proposals for personal services from interested consultants. A document that is released to prospective contractors in connection with a negotiated procurement that defines the agency's requirements.
Sole Source	A contract that is awarded without competition.
Spiral Model	A systems engineering methodology in which system requirements are developed based on extensive prototyping and analysis.
Statement of Work	A description of the services and products to be provided by a contractor along with the contractor's overall responsibilities in connection with these items. The Statement of Work is contained both in the request for proposals and the contract. Also known as Work Scope
Systems Integrator	A contractor assigned responsibility for providing all personal services required for system development. This may include software development, systems integration, inspection and testing.
Systems Manager	A contractor assigned responsibility for providing all personal services required to implement a project. Systems managers may be given responsibility for system planning, design, software development, systems integration, inspection and testing.
Task Order	A contract form in which work assignments are divided into tasks that are defined once the contract is underway. Task order contracts require the agency to release a task order to the contractor. The contractor responds with a brief proposal and cost estimate. If the contractor's submission is acceptable, work on that task is authorized.
Terms and Conditions	Contract requirements that define all of the responsibilities of both parties to the contract except for the work to be performed.
Time and Materials	A form of reimbursement in which contractors are reimbursed for the actual cost of performing the work plus a fee that is a percentage of the reimbursed costs.
Waterfall Model	A systems engineering methodology in which the project planning, design, implementation and testing steps are performed sequentially
Work Allocation	As used in the guidelines, work allocation refers to the assignment of responsibilities to various project team members including the agency, contractors and consultants

ACRONYMS

CCTV	Closed circuit television
COTS	Commercial off the shelf
DBOM	Design-Build Operate and Maintain
DMS	Dynamic Message Sign
DOT	Department of Transportation
IFB	Invitation for Bids
IT	Information Technology
ITN	Invitation to Negotiate
ITS	Intelligent Transportation Systems
RFP	Request for proposals
SOW	Statement of Work
TSMO	Transportation Systems Management and Operations

APPENDIX A

REFERENCES

ID	Author (Last, First, MI)
7	Tanner, VL

Title
METRORAIL PROJECTS RACING TO FIND UNCERTAIN FUTURE

Publisher	Date
McGraw-Hill Companies, Incorporated	9/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The article describes elements of each of the three projects and shows how the design-build approach permitted collaboration between contractors and the agency that resulted in efficiencies and cost savings.

Source	Procuring Agency
TRIS Online	Regional

ID	Author (Last, First, MI)
8	Neal, A

Title
USING TECHNOLOGY TO ENHANCE PARATRANSIT SERVICE

Publisher	Date
Bobit Publishing Company	8/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
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Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The move to an electronic scheduling system can be made easier and more cost- effective if paratransit agencies retain hardware, software and network providers to design, build and implement customized solutions.

Source	Procuring Agency
TRIS Online	Regional

ID	Author (Last, First, MI)
9	McQueen, R

Title
"ROAD-TESTING" ITS : SYSTEM-MANAGER CONTRACTING IN PRACTICE

Publisher	Date
Public Works Journal Corporation	7/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary
This article describes an intelligent transportation system (ITS) management project along a major corridor in Florida. The contract is using the System Manager approach.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
10	Smith, NC

Title
FEDERAL DESIGN-BUILD REGS LIMIT INNOVATIVE CONTRACTING

Publisher	Date
Public Works Financing	1/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary
The FHWA rule on Design-Build-Contracting has placed significant limitations on the ability of state and local agencies. This article discusses the potential implications of this new FHWA rule for transport-related contracting and procurement.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
11	Christodoulou, S

Title

STUDY ON PROCUREMENT OF ARCHITECTURAL AND ENGINEERING SERVICES FOR PUBLIC WORKS: CASE FOR QUALIFICATIONS-BASED SELECTION

Publisher	Date
Transportation Research Board	1/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [x] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

A study of New York City procurements comparing qualification-based A/E selection vs. competitive pricing A/E selection.

Source	Procuring Agency
TRIS Online	Local

ID	Author (Last, First, MI)
12	Glazer, Lawrence Jesse

Title

INTELLIGENT TRANSPORTATION SYSTEMS AT THE 2002 SALT LAKE CITY OLYMPIC GAMES : TRAFFIC MANAGEMENT AND TRAVELER INFORMATION : CASE STUDY

Publisher	Date
Iteris, Inc.	1/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [x] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [x] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

UDOT followed a unique approach to contracting this deployment and the Case Study provides an overview of the successes and lessons-learned that arise from that effort.

Source	Procuring Agency
TRIS Online	Regional

ID	Author (Last, First, MI)
13	Cox, DO; Molenaar, KR; Ernzen, JJ; Henk, G; Matthews, TC; Smith, N; Levy, A; Williams, RC; Gee, F; Kolb, J; Sanderson, L; Whited, GC; Wight, JW; Yakowenko, G

Title
CONTRACT ADMINISTRATION: TECHNOLOGY AND PRACTICE IN EUROPE

Publisher	Date
American Trade Initiatives	10/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [x] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
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- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This paper documents a scanning tour to Portugal, the Netherlands, France and England to investigate alternative contract administration procedures for possible implementation in the United States.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
14	Mohaddes, A

Title
COUNCIL REPORT SUMMARY: INNOVATIVE TRAFFIC CONTROL EQUIPMENT PROCUREMENT METHODS

Publisher	Date
Institute of Transportation Engineers	4/1/2000

This resource contains information on the following categories:

Work Allocation
- [x] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [x] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
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Contract Form
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The report details the following equipment procurement methods: engineer/contractor, system manager, two-step methods, design/build, life-cycle costing, functionality, sole source, one-step method, public/private, design competition

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
15	American Association of State Highway & Transp Off

Title: ITS SOFTWARE: EFFECTIVE ACQUISITION PRACTICES

Publisher	Date
American Association of State Highway & Transp Off	3/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This report documents and presents the results of a study of effective software acquisition practices of ITS and software acquisition and engineering techniques that have proven to be effective in other industries.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
16	Department of Transportation (FHWA & FTA)

Title: COMMUNICATIONS FOR INTELLIGENT TRANSPORTATION SYSTEMS: SUCCESSFUL PRACTICES - A CROSS-CUTTING STUDY

Publisher	Date
Department of Transportation (FHWA & FTA)	11/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
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- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

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- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

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- [ ] Task Order
- [ ] Purchase Order
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- [ ] Phased

Other Considerations
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- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The document addresses several of the key technical issues, which arise in selecting telecommunications solutions; including leasing vs. owning.

Source	Procuring Agency
TRIS Online	

ID	Author (Last, First, MI)
17	Trombly, J; Luttrell, T

Title
A CASE STUDY: THE LAS VEGAS FREEWAY AND ARTERIAL MANAGEMENT SYSTEM, USE OF A SYSTEMS MANAGER CONTRACTOR TO PROCURE ITS

Publisher	Date
Science Applications International Corporation	3/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The purpose of this series is to show that other procurement options are available under Federal-aid regulations for projects that do not meet the definition of construction.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
18	Trombly, J; Luttrell, T

Title
A CASE STUDY: GEORGIA'S INTELLIGENT TRANSPORTATION SYSTEM, NAVIGATOR SYSTEMS INTEGRATOR CONTRACT, USE OF A SYSTEMS INTEGRATOR TO MANAGE ITS IMPLEMENTATION

Publisher	Date
Science Applications International Corporation	3/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [x] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The purpose of this series is to show that other procurement options are available under Federal-aid regulations for projects that do not meet the definition of construction.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
19	Trombly, J; Luttrell, T

Title: A CASE STUDY: MICHIGAN INTELLIGENT TRANSPORTATION SYSTEM CENTER, USE OF A DESIGN/BUILD/WARRANTY CONTRACT

Publisher	Date
Science Applications International Corporation	3/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
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- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The purpose of this series is to show that other procurement options are available under Federal-aid regulations for projects that do not meet the definition of construction.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
20	Kraft, Walter H.

Title: PROCUREMENT OF INTELLIGENT TRANSPORTATION SYSTEMS

Publisher	Date
Parsons Brinckerhoff	1/1/2000

This resource contains information on the following categories:

Work Allocation
- [x] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [x] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

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- [ ] Purchase Order
- [ ] Other
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This paper focuses on procurement methods for Intelligent Transportation Systems (ITS). It first identifies four major categories of procurement: engineer/contractor; design/build, system manager/system integrator, and shared resources.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
21	Abernethy, Bruce

Title
QUALITY CONTROL : MAY THE ITS TASK FORCE BE WITH YOU

Publisher	Date
Kimley-Horn and Associates	1/1/1999

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [x] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article focuses on the following elements of contracting, including contractual obligations, bidding, sales cycles communications infrastructure, and design/build projects.

Source	Procuring Agency
TRIS Online	

ID	Author (Last, First, MI)
22	Gransberg, DD

Title
DESIGN/BUILD IN TRANSPORTATION FROM THE RESEARCH PERSPECTIVE

Publisher	Date
American Society of Civil Engineers	7/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
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- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
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- [ ] Other
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- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article looks at the research community as an excellent catalyst for capturing data regarding design/build projects, appropriately analyzing those data, and distilling them into useful information of value to the industry.

Source	Procuring Agency
TRIS Online	

ID	Author (Last, First, MI)
23	Mantri, YS; Jordan, DC

Title
ARIZONA'S STATEWIDE SIGNAL SYSTEM PROCUREMENT - 2002 STATUS

Publisher	Date
ITS America	1/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The paper gives an overview of the RFP development process for signal systems software procurement and identifies the keys to success along with the benefits realized by the participants.

Source	Procuring Agency
TRIS Online	Regional

ID	Author (Last, First, MI)
24	Jakes, AS

Title
PROCUREMENT METHODS FOR AUTOMATED GUIDEWAY TRANSIT SYSTEMS

Publisher	Date
Institute for Transportation, Incorporated	5/1/1999

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The objective of this article is to review currently used and recently considered procurement methods and recommend methodology for their selection depending on project requirements.

Source	Procuring Agency
TRIS Online	Regional

ID	Author (Last, First, MI)
25	Samuel, Peter

Title
DEATH BY LOW BIDS? : LOW BIDS ARE CLAIMED TO BE KILLING THE ITS INDUSTRY BEFORE IT HAS BECOME ESTABLISHED

Publisher	Date
	1/1/1999

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article examines concerns that the Intelligent Transportation Systems (ITS) industry is suffering from long-standing procurement procedures that are based on a lowest bid basis.

Source	Procuring Agency
TRIS Online	State

ID	Author (Last, First, MI)
26	L.S. Gallegos & Associates, Inc.

Title
ITS PROCUREMENT RESOURCE GUIDE Innovative Contracting Practices for ITS Task E - Final Report

Publisher	Date
L.S. Gallegos & Associates, Inc.	4/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [x] Low-Bid
- [x] Negotiated
- [x] Sole Source
- [x] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This report presents the results of research on procurement-related legal and non-technical issues which may be constraining the deployment of Intelligent Transportation Systems (ITS).

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
27	GORD, Ali

Title: FHWA Federal-Aid ITS Procurement Regulations and Contracting Options

Publisher	Date
Federal Highway Administration	10/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This report has been developed to assist State and local transportation agencies understand the contracting techniques available for design and construction of Intelligent Transportation Systems (ITS) projects.

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
28	FHWA

Title: PROCUREMENT INFORMATION FOR ITS PROJECTS

Publisher	Date
FHWA	5/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
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Award Method
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- [ ] Other

Contract Type
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- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

THIS MATERIAL IS AN OVERVIEW OF THE FEDERAL PROCUREMENT REQUIREMENTS FOCUSING ON THE DESIGN-BUILD PROCUREMENT METHOD AND IT PROVIDES INFORMATION ON HOW THE METHOD CAN BE UTILIZED AS AN EFFECTIVE STRATEGY TO DEVELOP AND DEPLOY ITS INFRASTRUCTURE.

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
29	Ehlinger, Erin, B.

Title
SUCCESSFUL TRAFFIC SIGNAL SYSTEM PROCUREMENT TECHNIQUES

Publisher	Date
FHWA	3/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This short report outlines processes that are supportive of successful traffic signal system procurements. It addresses equipment as well as software and system procurements.

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
30	Salwin, Arthur, E.

Title
The Road to Successful ITS Software Acquisition Volume I: Overview and Themes

Publisher	Date
Federal Highway Administration	7/1/1998

This resource contains information on the following categories:

Work Allocation
- [x] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [x] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This document assembles best practices and presents practical advice on how to acquire the software components of ITS.

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
31	Salwin, Arthur, E.

Title

The Road to Successful ITS Software Acquisition Volume II: Software Acquisition Process Reference Guide

Publisher	Date
Federal Highway Administration	7/1/1998

This resource contains information on the following categories:

Work Allocation

- [x] Contractor/Consultant
- [x] Design Consultant
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- [ ] System Integrator
- [x] Commodit
- [ ] Services
- [x] Other

Award Method

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- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

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- [x] Cost Reimbursemen
- [x] Time _Materials
- [x] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations

- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This document assembles best practices and presents practical advice on how to acquire the software components of ITS. Chapter 11 focuses on "Selecting the Contracting Vehicle"

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
32	

Title

Course on ITS software acquisition including how to deal with intellectual property rights

Publisher	Date
DOT Joint Program Office (JPO) from the Professional Capacity Building Site	1/1/2000

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Identifies appropriate contract mechanism for software projects; suggests amicable resolutions for intellectual property rights issues in order to avoid litigation…

Source	Procuring Agency
DOT Joint Program Office (JPO) from the Professional Capacity Building Site	State

ID	Author (Last, First, MI)
33	Clarke, C. A.; Marshall, K. R.; Cox, Christine R.

Title
Multi-jurisdictional procurement in the I-95 corridor : lessons learned : a white paper on the analog HAR procurement

Publisher	Date
ITS America, Washington DC	1/1/1998

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
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Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
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- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This paper examines the procurement and implementation process utilized; discusses the problems encountered; outlines lessons learned; and suggests a format for future procurements by the Coalition

Source	Procuring Agency
ITS America. Meeting (8th : 1998 : Detroit, Mich.). Transportation technology for tomorrow :	Regional

ID	Author (Last, First, MI)
34	Marston, Pamela P.

Title
Changeable Message Signs: Avoiding Design and Procurement Pitfalls

Publisher	Date
FHWA/Turner-Fairbank Highway Research Center	9/1/1993

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [x] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article describes the various CMS technologies and their uses, explains some of the challenges with regard to procurement and implementation, and recommends solutions to the problems.

Source	Procuring Agency
FHWA/Turner-Fairbank Highway Research Center	State

ID	Author (Last, First, MI)
35	Williams, Bradley P.

Title

ITS procurement : analysis and recommendations

Publisher	Date
Charlottesville, Va. : Virginia Transportation Research Council	1/1/1994

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [x] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [x] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This study examines the constraints imposed on procurement by federal and state laws and proposes approaches to procuring ITS.

Source	Procuring Agency
Mn/DOT Library TE228.3.W54 1994	State

ID	Author (Last, First, MI)
36	Scrase, Richard.

Title

Inching forward

Publisher	Date
ITS international	1/1/1999

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
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Contract Form

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- [ ] Purchase Order
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- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

How the Inch Project is simplifying the procurement process for transportation agencies…

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
37	Cronin, Brian P.

Title
Design/build : Turning the key to effective intelligent transportation system (ITS) procurement

Publisher	Date
Institute of Transportation Engineers	1/1/1996

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Contract Type
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- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
38	Colosimo, Sara. ; Patrolia, William J

Title
Use of a system contractor for the design, procurement, and installation of an adverse-visibility warning system

Publisher	Date
ITS America	1/1/1995

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Other Considerations
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
39	O'Neill, Gene.

Title
Applying DoD procurement experience to highway planning

Publisher	Date
ITS America	1/1/1995

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
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- [ ] Negotiated
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Other Considerations
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- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
40	Gillon, Clive. ; Kott, Leonard

Title
A call for the review of ITS procurement policy from the perspective of a systems integrator

Publisher	Date
ITS America.	1/1/1995

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [x] System Integrator
- [ ] Commodit
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- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
41	Pearce, Vincent P.

Title

Making the procurement process work for you in ITS deployment

Publisher	Date
ITS America.	1/1/1995

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
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- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
42	Tarnoff, Philip J.

Title

A tale of software acquisition : Is bigger necessarily better prepared?

Publisher	Date
Traffic technology international.	10/1/1997

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
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- [ ] Cooperative Procurement
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- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
Transportation Libraries Catalog	

ID	Author (Last, First, MI)
43	PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Title

DESIGN-BUILD PRACTICE REPORT

Publisher	Date
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	9/1/2002

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
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- [x] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [x] Set-Asides
- [x] Payment Terms

Summary

This report describes the major components of the design-build process and summarizes the practices of the various agencies utilizing design-build services.

Source	Procuring Agency
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	State

ID	Author (Last, First, MI)
44	PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Title

DESIGN-BUILD PROCUREMENT PROCESS REPORT

Publisher	Date
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	3/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The recommended design-build process of this report is based on a review of design-build practices used in the United States and conforms to the pending NY State legislation and the proposed FHWA rules and regulations concerning design-build contracting.

Source	Procuring Agency
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	State

ID	Author (Last, First, MI)
45	PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Title

DESIGN-BUILD PROCUREMENT PROCESS REPORT Appendix 1 – Report on the Design–Build Strategic Planning Workshop

Publisher	Date
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	3/1/2003

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☑ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☐ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☐ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Contract Form

- ☐ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Summary

This references summarizes the results of a workshop held to push forward the adoption of design-build procurement…

Source	Procuring Agency
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	State

ID	Author (Last, First, MI)
46	PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Title

DESIGN-BUILD PROCUREMENT PROCESS REPORT Appendix 2 – Compatibility of NYSDOT Procedures and Guidelines with Design-Build Procurement

Publisher	Date
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	3/1/2003

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☑ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☐ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☐ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Contract Form

- ☐ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Summary

This report compares existing NY State procurement procedures vs. Design-Build procurement procedures.

Source	Procuring Agency
NEW YORK STATE DEPARTMENT OF TRANSPORTATION	State

ID	Author (Last, First, MI)
47	Reed, Thomas B.; LeBay, Mark R.

Title
A Model of Systems Integration to Facilitate ITS Deployment

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The effort to develop the systems integration model began with a case study of the successful FAST-TRAC TIMS system integration efforts. This report documents the systems integration model used.

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	Local

ID	Author (Last, First, MI)
48	Mantri, Yogesh S. P.E.; Jordan, Christopher D. P.E.

Title
A Unique Approach to Statewide Procurement of ATMS Software – A Case Study in Maricopa County, Arizona

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The paper includes a detailed overview of the development of the regional procurement request for proposals and scope requirements.

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	State

ID	Author (Last, First, MI)
49	

Title
ITS Procurement Approach Overview

Publisher	Date
	2/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This eleven-page document, which was distributed at the TRB Annual meeting in an ITS procurement session, summarizes available methods that can be used to procure ITS. It also includes a four-page FHWA Memorandum entitled "ACTION: Procuring ITS Projects."

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	State

ID	Author (Last, First, MI)
50	Yermack, Larry

Title
ITS Technology Procurement: Highlights of a Presentation at the AASHTO Advanced Transportation Systems (ATS) Subcommittee Meeting

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [x] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This presentation, by ITS America's Chairman Larry Yermack, provides useful advice from the supplier perspective to any transportation agency embarking on a major ITS initiative.

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	State

ID	Author (Last, First, MI)
51	

Title

The Applicability of ITOP II for ITS Procurement: A discussion with ITOP Director Rebecca West

Publisher	Date
ITS Cooperative Deployment Network (ICDN)	8/1/2001

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☐ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☐ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☑ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Contract Form

- ☑ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Summary

ICDN Editor Jerry Werner recently discussed how ITOP might apply to federal/state/local ITS project procurement and administration with ITOP Director Rebecca West.

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	Federal

ID	Author (Last, First, MI)
52	

Title

FHWA Memorandum: Procurement Information for ITS Projects

Publisher	Date
	5/1/1997

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☑ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☑ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☐ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Contract Form

- ☐ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Summary

Discusses types of ITS projects and the alternatives available under federal aid.

Source	Procuring Agency
ITS Cooperative Deployment Network (ICDN)	State

ID	Author (Last, First, MI)
53	

Title
Guideline to Managing Performance Based Operations and Maintenance Contract

Publisher	Date
Virginia Department of Transportation	12/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [x] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This report presents an overview of the benefits and process for implementing performance based specifications in an incentive award type contract for equipment maintenance. The report provides guidelines for data collection and analysis of maintenance…

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
54	Allan J. DeBlasio*, David Jackson**, Anne C. Tallon**, Gerald M. Powers**, John P. O'Donnell*

Title
Successful Approaches to Deploying a Metropolitan Intelligent Transportation System

Publisher	Date
US DOT	3/1/1999

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [x] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
Volpe Center analysts examined the institutional and other non-technical impediments that public sector participants encountered in deploying ITS

Source	Procuring Agency
Electronic Document Library	Regional

ID	Author (Last, First, MI)
55	

Title
Non-technical Constraints and Barriers to the Implementation of Intelligent Transportation Systems

Publisher	Date
US DOT	1/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This is a mandated report to Congress addressing the non-technical constraints to the implementation of the ITS.

Source	Procuring Agency
Electronic Document Library	State

ID	Author (Last, First, MI)
56	DEBLASIO, ALLAN

Title
What's Yours, Mine, and Ours: Overcoming Intellectual Property Rights Issues — A Cross-Cutting Study

Publisher	Date
US DOT - Volpe	8/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This report speaks to IP rights.

Source	Procuring Agency
Electronic Document Library	State

ID	Author (Last, First, MI)
57	John A. Volpe National Transportation Systems Center

Title: DELAYS AFFECTING ITS PROJECTS - SUMMARY OF FINDINGS

Publisher	Date
US DOT	11/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Summary

This report documents the findings of a program review conducted from October 2002 to September 2003 that investigated what delays continue to affect ITS projects, including delays associated w/ contracting for software development and system integration.

Source	Procuring Agency
Electronic Document Library	State

ID	Author (Last, First, MI)
58	Tanner, VL

Title: THE NEED FOR SPEED : AUTOMAKERS TURN TO DESIGN-BUILD FOR FASTER-TO- MARKET DELIVERY

Publisher	Date
McGraw-Hill Companies, Incorporated	3/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

This article showcases the successes of two major automobile manufacturers whose design-build plants have successfully saved them money and accelerated construction times.

Source	Procuring Agency
TRISOnline	Private

ID	Author (Last, First, MI)
59	DEBLASIO, ALLAN

Title
WHAT HAVE WE LEARNED ABOUT ITS? CHAPTER 8: WHAT HAVE WE LEARNED ABOUT CROSS-CUTTING INSTITUTIONAL ISSUES?

Publisher	Date
US DOT/FHWA	12/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations
- [x] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This reference addresses ITS cross-cutting institutional issues including; procurement and IP…

Source	Procuring Agency
ITS Electronic Document Library	State

ID	Author (Last, First, MI)
60	

Title
Primer on Contracting 2000 (3rd Edition)

Publisher	Date
AASHTO	10/1/1999

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [x] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [x] Insurance
- [x] Disputes
- [ ] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This document lists various contracting techniques that are currently being used by the states in their highway programs.

Source	Procuring Agency
AASHTO	State

ID	Author (Last, First, MI)
61	Carpenter, Brian

Title: Performance-Based Contracting for the Highway Construction Industry

Publisher	Date
	2/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [x] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This document is an evaluation of the use of innovative contracting and performance specification in highway construction.

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
62	Yermack, Larry

Title: Intelligent Transportation System (ITS) Software Integration Project Risks Assessment and Mitigation

Publisher	Date
AASHTO	6/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This document identifies the use of various contract types in order to mitigate risks.

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
63	Anderson, Laurie L.

Title

Legal and Procurement Issues in forming Public-Private Partnerships in Minnesota

Publisher	Date
ITS America	1/1/1995

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Proceedings of the 5th Annual Meeting of ITS America	State

ID	Author (Last, First, MI)
64	Cadieux, Gena E.

Title

Government Procurement: Successful Decision Making When Uncle Sam Is Your Customer, Surface Transportation and the Information Age

Publisher	Date
ITS America	5/1/1992

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Proceedings of the 1992 Annual Meeting of ITS America	Federal

ID	Author (Last, First, MI)
65	Chen, An

Title

A Sociotechnological Perspective on Public-Private Partnership for IVHS Infrastructure - DRAFT

Publisher	Date
ITS America	1/1/1992

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Journal of ITS America Transactions	State

ID	Author (Last, First, MI)
66	Dahlin, Curtis

Title

Performance-Based Specifications and Testing Procedures for Portable Vehicle Classifiers

Publisher	Date
Minnesota Department of Transportation	

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Minnesota Department of Transportation	State

ID	Author (Last, First, MI)
67	O'Malley, Dennis M.

Title

Albany's Computerized Traffic Control System: A Credit to Cooperation." Computer Control Systems Application Group Newsletter

Publisher	Date
Institute of Transportation Engineers	10/1/1983

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [x] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Institute of Transportation Engineers Vol. 6, No.3	Local

ID	Author (Last, First, MI)
68	Ostrer, Michael E., Esq

Title

Contract Issues in Toll Road Agency Procurement of Intelligent Vehicle and Highway Systems

Publisher	Date
ITS America	4/1/1993

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
ITS America	

ID	Author (Last, First, MI)
69	

Title
Traffic Control Systems Handbook

Publisher	Date
U.S. Department of Transportation, Federal Highway Administration	2/1/1996

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
FHWA (Report No. sA-9S-032)	

ID	Author (Last, First, MI)
70	Lyons, Kevin J.

Title
Buying for the Future: Contract Management and the Environmental Challenge

Publisher	Date
Pluto Press	1/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Non-Transportation	

ID	Author (Last, First, MI)
71	Moore, David C.

Title
Government Contracting : How to Bid, Administer, and Get Paid

Publisher	Date
Wiley	1/1/1995

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency

ID	Author (Last, First, MI)
72	

Title
Advances in Traffic Data Collection and Management

Publisher	Date
FHWA	12/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
73	

Title
Guide to Methods and Procedures in Contract Maintenance

Publisher	Date
AASHTO	1/1/1987

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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- [ ] Other

Contract Type
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- [ ] Time _Materials
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Contract Form
- [ ] Task Order
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- [ ] Other
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Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
AASHTO	

ID	Author (Last, First, MI)
74	

Title
Making Contracting Work Better and Cost Less

Publisher	Date
US Dept of Energy	1/1/1994

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency

ID	Author (Last, First, MI)
75	

Title

NCHRP Guidelines Detail Innovative Contracting Methods

Publisher	Date
Texas Transportation Researcher, Vol 36, #2	1/1/2000

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
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- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
http://tti.tamu.edu/researcher/v36n2/nchrp_guidelines.stm	

ID	Author (Last, First, MI)
76	

Title

Contracting Methods for Highway Construction

Publisher	Date

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

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- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Prepared by the Committee on Construction Management Chairman: Steve DeWitt, North Carolina Department of Transportation

Source	Procuring Agency

ID	Author (Last, First, MI)
77	Hanncher, Donn E

Title
Managing Change in State DOTs – Scan 2 of 8: Innovations in Private Involvement in Project Delivery

Publisher	Date
NCHRP	4/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
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Award Method
- [ ] Low-Bid
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Contract Type
- [ ] Fixed Price
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- [ ] Other

Other Considerations
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- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
78	Ford, Mark L.

Title
Managing Change in State DOTs – Scan 7of 8: Innovations in Public-Public Partnering and Relationship Building in State DOTs

Publisher	Date
NCHRP	5/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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- [ ] Other

Contract Type
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- [ ] Cost Reimbursemen
- [ ] Time _Materials
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Other Considerations
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- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
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- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
79	

Title: Managing Change in State DOTs – Scan 8of 8: Innovations in Project Financing

Publisher: NCHRP | **Date:** 5/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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- [ ] Cost Reimbursemen
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- [ ] Penalties/Incentives
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Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source | **Procuring Agency:** State

ID	Author (Last, First, MI)
80	Anderson, Stuart D.

Title: NCHRP Report 451: Guidelines for Warranty, Multi-Parameter, and Best-value Contracting

Publisher: NCHRP | **Date:** 1/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
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- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [x] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source | **Procuring Agency:** State

ID	Author (Last, First, MI)
81	Warne, Thomas R.

Title

NCHRP Synthesis 313: State DOT Outsourcing and Private-Sector Utilization

Publisher	Date
NCHRP	1/1/2003

This resource contains information on the following categories:

Work Allocation
- [x] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [x] Fixed Price
- [x] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
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- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [x] Set-Asides
- [x] Payment Terms

Summary

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
82	Ardila, Arturo

Title

Planning Large Transportation Projects: A Six-Stage Model

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Massachusetts Institute of Technology	

ID	Author (Last, First, MI)
83	Hancher, Donn E.

Title

Quality-based Prequalification of Contractors

Publisher	Date
	1/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
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- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Contract Type
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- [ ] Time _Materials
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Contract Form
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- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Prepared for A2F05 Construction Management Committee, 81st Annual Meeting, Transport	

ID	Author (Last, First, MI)
84	Cummins, Seth

Title

Transportation Construction Contracts

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Contract Type
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- [ ] Cost Reimbursemen
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- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
TRB	

ID	Author (Last, First, MI)
85	Carson, Jodi

Title
Valuation of Temporary Transportation Facility Use Losses

Publisher	Date
	12/30/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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- [ ] Other

Contract Type
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- [ ] Time _Materials
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- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
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Other Considerations
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency
Montana DOT Research Bureau	State

ID	Author (Last, First, MI)
86	Daniels, Ginger

Title
Guidelines for Funding Operations and Maintenance of Intelligent Transportation Systems/Advanced Traffic Management Systems

Publisher	Date
USDOT	1/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
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Contract Type
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- [ ] Cost Reimbursemen
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- [ ] Other

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- [ ] Purchase Order
- [ ] Other
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- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Source	Procuring Agency

ID	Author (Last, First, MI)
87	Syverud, Kent

Title

Legal Constraints to the Research, Development, and Deployment of IVHS Technology in the United States

Publisher	Date
USDOT	3/1/1993

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency

ID	Author (Last, First, MI)
88	

Title

ITS Procurement Resource Guide Virginia DOT Public-Private Procurement Issues and Accomplishments and Interim Report

Publisher	Date
USDOT	1/1/1997

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
	State

ID	Author (Last, First, MI)
89	Smith, Gary R.

Title
Quality-Based Performance Rating of Contractors for Prequalification and Bidding Purposes

Publisher	Date
NCHRP	3/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency

ID	Author (Last, First, MI)
90	Trombly, Jeffrey

Title
A Case Study Chart II Software Upgrade Using a Design Competition to Procure ITS Software

Publisher	Date
USDOT	3/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [x] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Summary

Source	Procuring Agency
ITS Electronic Document Library (#13462)	State

ID	Author (Last, First, MI)
91	MIS Systems

Title: Applied Acquisition - Defining Performance-Based Contracts

Publisher	Date
Mitretek Systems	12/1/1998

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [x] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This article discusses performance based contracting which often means different things to different assets.

Source	Procuring Agency
www.mitretek.org	

ID	Author (Last, First, MI)
92	USDA Graduate School

Title: Writing Performance-Based SOW's

Publisher	Date
USDA Graduate School	12/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [x] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This publication is designed to be a "how to cookbook" with step-by-step instructions on methods to accomplish each stage of the process for writing performance based SOW's.

Source	Procuring Agency
USDA Graduate School	

ID	Author (Last, First, MI)
93	Shen, Yujing

Title
Selection Incentives in a Performance-Based Contracting Systems

Publisher	Date
The Gale Group	12/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [x] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article discusses the issues of making sure the issue of performance-based contracting is in the best interests of the organization for which it is to serve.

Source	Procuring Agency
www.findarticles.com	

ID	Author (Last, First, MI)
94	Woods, William T.

Title
Performance-Based Contracting

Publisher	Date
US General Accounting Office	

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article discusses the elements of performance-based contracts and the seven steps to performance based acquisition.

Source	Procuring Agency
www.gao.gov	

ID	Author (Last, First, MI)
95	Officer of Federal Procurement Policy

Title
A Guide to Best Practices for Performance-based Contracting

Publisher	Date
Office of Management and Budget	12/1/1998

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This guide contains best practices that have proven useful in drafting statements of work, solicitations and quality assurance plans, and in awarding and administering performance-based service contracts.

Source	Procuring Agency
www.arnet.gov	

ID	Author (Last, First, MI)
96	National Association of State Purchasing Officials

Title
Buying Smart: Blueprint in Action

Publisher	Date
National Association of State Purchasing Officials	12/1/1998

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This is a report outlining procurement strategies employed by state governments in the acquisition of information technology commodities.

Source	Procuring Agency
www.naspo.org	

ID	Author (Last, First, MI)
97	Undersecretary of Defense

Title
Acquisition, Technology and Logistics - Performance Based Payout (PBP)

Publisher	Date
Undersecretary of Defense	12/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
A manual that describes how performance based payments is a new financial tool that strengthens the government industry relationship and the commitment to revolutionize the business process.

Source	Procuring Agency
USD (AT&L) PBP Policy	

ID	Author (Last, First, MI)
98	US Department of State

Title
An Interagency Task Force Report on Performance-based Service Acquisitions

Publisher	Date
US Department of State, DMB	12/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This is a report on the status of performance-based service contracts crossing agencies with the federal government.

Source	Procuring Agency
www.statebuy.state.gov	

ID	Author (Last, First, MI)
99	Unisys Corporation

Title
Measuring Performance in the Information Technology Utility

Publisher	Date
Unisys Corporation	12/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This article discusses the importance of an integrated, rich-web performance metrics as a critical factor for managing a performance-based IT contract.

Source	Procuring Agency

ID	Author (Last, First, MI)
100	Hasselbaugh, Brett

Title
Getting More for Less: Driving Value in the IT Utility

Publisher	Date
Unisys Corporation	12/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This paper discusses how to get more for less in IT utility and the approach to use in driving value when preparing a performance-based statement of work.

Source	Procuring Agency
Unisys Corporation	

ID	Author (Last, First, MI)
101	IBM Corporation

Title
Making Performance-based Contracting Perform: What Federal Government Can Learn from State and Local Governments

Publisher	Date
IBM Corporation	12/1/2002

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This report identifies major conclusions and lessons learned from the review of 10 performance-based contracting examples.

Source	Procuring Agency
IBM Corporation	

ID	Author (Last, First, MI)
102	Dipompo, Luke and Robinson, Mark

Title
Performance-based Contracting in the District of Columbia

Publisher	Date
Us Department of Transportation	12/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [x] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This discussion focuses on the key issues confronting the DC street and bridge system and the reason for turning to performance-based asset preservation.

Source	Procuring Agency
Us Department of Transportation	

ID	Author (Last, First, MI)
103	DeMaio, Carl

Title: Performance-based Contracting in Government

Publisher	Date
The Performance Institute	

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Topics of interest include, what makes a contract performance-based, the different uses of measures in contracts, selecting performance measures and lessons learned.

Source	Procuring Agency
www.performanceweb.org	

ID	Author (Last, First, MI)
104	Department of Management and Budget

Title: Performance-based Service Acquisition - Contracting for the Future

Publisher	Date
Office of Federal Procurement Policy	7/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The group focused on the areas of change: (1) Modifying the Federal Acquisition Regulations regarding PBSA, (2) Modifying reporting requirements and (3) Improving the quality, currency and availability of guidance.

Source	Procuring Agency
Department of Management and Budget Web site	

ID	Author (Last, First, MI)
105	Kelmar, Steven

Title
Performance-based Service Contracting Checklist

Publisher	Date
Office of Management and Budget	8/1/1997

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [x] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [x] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
The checklist was developed as a guide when developing a performance-based solicitation contract - a task order to determine if an existing contract can be defined as performance based.

Source	Procuring Agency
www.dof.gov	

ID	Author (Last, First, MI)
106	Hensher, David and Stanley, John

Title
Performance-based Contracts in Public Transportation: The Melbourne Experience

Publisher	Date
Hensher and Stanley	12/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [x] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This paper reviews recent franchising of public transport services in Melbourne, Australia, to shed light on the proposition.

Source	Procuring Agency
Hensher and Stanley	

ID	Author (Last, First, MI)
107	Carpenter, Brian/Fekpe, Edward and Gopalakrishna, Deepak

Title

Peformance-based Contraccting for the Highway Construction Industry

Publisher	Date
Battelle	12/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [x] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [x] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [x] Phased

Summary

This paper defines performance-specification-based contracting as structuring the contract around the desired results rather than the methods that should be used.

Source	Procuring Agency
Koch Industries	

ID	Author (Last, First, MI)
108	Hyman, William

Title

Guide to Performance-based Operations Contracting

Publisher	Date
Department of Transportation	12/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [x] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

This guide provides step-by-step guidance regarding how to develop a performance-based contract for transportation operators.

Source	Procuring Agency
Booz Allen Hamilton, Inc	

ID	Author (Last, First, MI)
109	Mechling, Jerry and Sweeney, Victoria

Title
Finding and Funding Performance Contracting IT Projects

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This report addresses why many governments are turning to creative funding for IT projects that rely less on traditional tax-levy budgets.

Source	Procuring Agency
www.govfed.net	

ID	Author (Last, First, MI)
110	Kenner, Brian

Title
Using Strategic Execution to Manage Vendors for Results

Publisher	Date
Learning Framework	12/1/2000

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [x] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [x] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [x] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [x] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This paper focuses on the purchasing organization as their service providers or performance-based metrics which in turn moves the relationship from one of managing minutia to one of managing results.

Source	Procuring Agency
Learning Framework	

ID	Author (Last, First, MI)
114	

Title

49 CFR - PART 18 - UNIFORM ADMINISTRATIVE REQUIREMENTS FOR GRANTS AND COOPERATIVE AGREEMENTS TO STATE AND LOCAL GOVERNMENTS

Publisher	Date

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

This part establishes uniform administrative rules for Federal grants and cooperative agreements and sub-awards to State, local and Indian tribal governments.

Source	Procuring Agency
U.S. Code of Federal Regulations	

ID	Author (Last, First, MI)
115	

Title

Procurement and Contracting - Some Handy Checklists

Publisher	Date
	1/4/2004

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

These checklists are provided as tools to assist in creating technology procurement documents and contracts.

Source	Procuring Agency
2004 Interoperable Communications Technology Training Program	

ID	Author (Last, First, MI)
116	

Title
Contract Administration Core Curriculum Participant's Manual and Reference Guide 2001 (Rev. 1)

Publisher	Date
FHWA	1/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This manual/guide is designed to discuss contract provisions, administrative procedures, and applicable policies related to Federal-aid design and construction contracts.

Source	Procuring Agency
FHWA Website - http://www.fhwa.dot.gov/programadmin/contracts/coretoc.htm	

ID	Author (Last, First, MI)
117	

Title
New York State Procurement Guidelines

Publisher	Date
New York State Office of General Services	3/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary
This document is designed to assist New York State agencies when procuring commodities, services and technology.

Source	Procuring Agency
New York State OGS Website: http://www.ogs.state.ny.us/procurecounc/default.asp	State

ID	Author (Last, First, MI)
118	

Title

New York State Procurement Guidelines - Appendix A: Applicable Legal Requirements

Publisher	Date
New York State Office of General Services (OGS)	5/1/2003

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

A number of federal and New York State laws, rules, and regulations impact on NYS procurements. The NYS Department of Law summarizes some of these requirements into Appendix A.

Source	Procuring Agency
New York State OGS Website: http://www.ogs.state.ny.us/procurecounc/A_01.asp	State

ID	Author (Last, First, MI)
119	

Title

New York State Procurement Guidelines - Appendix B: GENERAL SPECIFICATIONS (Commodities and Non-Technology Services)

Publisher	Date
New York State Office of General Services (OGS)	3/1/2001

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The terms and conditions set forth in this Appendix are expressly incorporated in and applicable to all procurements and resulting procurement contracts let by the OGS Procurement Services Group…

Source	Procuring Agency
New York State OGS Website: http://www.ogs.state.ny.us/purchase/BidTemplate/Appendix	State

ID	Author (Last, First, MI)
120	

Title

New York State Procurement Guidelines - Appendix B1: GENERAL SPECIFICATIONS (Technology Products and Services)

Publisher	Date
New York State Office of General Services (OGS)	3/1/2001

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

The terms and conditions set forth in this Appendix B-1 are expressly incorporated in and applicable to all procurements and resulting procurement contracts let by the Office of General Services Procurement Services Group…

Source	Procuring Agency
New York State OGS Website: http://www.ogs.state.ny.us/purchase/BidTemplate/Appendix	State

ID	Author (Last, First, MI)
121	

Title

New York State Procurement Guidelines - Appendix C : Related Procurement Information

Publisher	Date
New York State Office of General Services (OGS)	8/1/2003

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Summary

Appendix C supplements the guidelines with instructional bulletins which are broad in nature.

Source	Procuring Agency
New York State OGS Website: http://www.ogs.state.ny.us/procurecounc/appendix_C.asp	State

ID	Author (Last, First, MI)
122	State of Texas

Title

The State of Texas Procurement Manual

Publisher	Date
Procurment Division Publications Section	6/1/2003

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☐ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☐ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☐ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Contract Form

- ☐ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Summary

Source	Procuring Agency
www.tbpc.state.tx.us/stpurch	State

ID	Author (Last, First, MI)
123	State of Virginia

Title

Agency Procurement and Surplus Property Manual

Publisher	Date
Dept. of General Services, Div. of Purchases and Supply	9/1/1998

This resource contains information on the following categories:

Work Allocation

- ☐ Contractor/Consultant
- ☐ Design Consultant
- ☐ Design-Build
- ☐ System Manager
- ☐ System Integrator
- ☐ Commodit
- ☐ Services
- ☐ Other

Award Method

- ☐ Low-Bid
- ☐ Negotiated
- ☐ Sole Source
- ☐ Other

Contract Type

- ☐ Fixed Price
- ☐ Cost Reimbursemen
- ☐ Time _Materials
- ☐ Penalties/Incentives
- ☐ Other

Contract Form

- ☐ Task Order
- ☐ Purchase Order
- ☐ Other
- ☐ Phased

Other Considerations

- ☐ IP Rights
- ☐ Cancellation Clauses
- ☐ Contract Limits
- ☐ Licenses
- ☐ Insurance
- ☐ Disputes
- ☐ Changes
- ☐ Warranties
- ☐ Cooperative Procurement
- ☐ Set-Asides
- ☐ Payment Terms

Summary

Source	Procuring Agency
www.dgs.state.va.us/dps	State

ID	Author (Last, First, MI)
124	State of California

Title: State Contracting Manual

Publisher	Date
Dept. of General Services	1/1/2004

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
www.dgs.ca.gov/ols	State

ID	Author (Last, First, MI)
125	State of Illinois

Title: Purchasing Operations Manual

Publisher	Date
Office of Business and Financial Services	7/1/2004

This resource contains information on the following categories:

Work Allocation
- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method
- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type
- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations
- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form
- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
www.obfs.uillinois.edu/obfshome.cfm?level=1&path=purchases&xmldata=purchases	State

ID	Author (Last, First, MI)
126	State of North Carolina

Title

Agency Purchasing Manual

Publisher	Date
Dept. of Genreral Services	1/1/2000

This resource contains information on the following categories:

Work Allocation

- [ ] Contractor/Consultant
- [ ] Design Consultant
- [ ] Design-Build
- [ ] System Manager
- [ ] System Integrator
- [ ] Commodit
- [ ] Services
- [ ] Other

Award Method

- [ ] Low-Bid
- [ ] Negotiated
- [ ] Sole Source
- [ ] Other

Contract Type

- [ ] Fixed Price
- [ ] Cost Reimbursemen
- [ ] Time _Materials
- [ ] Penalties/Incentives
- [ ] Other

Other Considerations

- [ ] IP Rights
- [ ] Cancellation Clauses
- [ ] Contract Limits
- [ ] Licenses
- [ ] Insurance
- [ ] Disputes
- [ ] Changes
- [ ] Warranties
- [ ] Cooperative Procurement
- [ ] Set-Asides
- [ ] Payment Terms

Contract Form

- [ ] Task Order
- [ ] Purchase Order
- [ ] Other
- [ ] Phased

Summary

Source	Procuring Agency
www.doa.state.nc.us/PandC/agpurman.htm	State

APPENDIX B

DETAILED SURVEY RESPONSE

Guide to Contracting ITS Projects Survey

ORGANIZATIONAL

1. General Information of Respondents

(Please refer to the presentation for repondents' details)

2. Does your agency have an organizational unit specifically organized for the acquisition and management of ITS systems?

	Number of Responses	Response Ratio
Yes	8	62%
No	5	38%
Total	13	100%

3. Does your agency use outside assistance to manage/oversee ITS project acqu sitions?

	Number of Responses	Response Ratio
Yes	6	46%
No	7	54%
Total	13	100%

4. Does your agency have the following in-house areas of expertise (please check all that app y)?

	Number of Responses	Response Ratio
IT System Administration	12	92%
IT System Maintenance	12	92%
IT System Operations	12	92%
Other, Please Specify	2	15%

LEVEL OF SUPPORT FOR ITS/OPERATIONS

5. Is ITS/Operations included in the agency's strategic plan?

	Number of Responses	Response Ratio
Yes	10	83%
No	0	0%

	Number of Responses	Response Ratio
N/A	2	17%
Total	12	100%

6. Do agency personnel participate in ITS National Meetings (ITS America, World Congress, etc)?

	Number of Responses	Response Ratio
Yes	12	92%
No	1	8%
N/A	0	0%
Total	13	100%

7. Do agency personnel attend ITS training annually?

	Number of Responses	Response Ratio
Yes	10	83%
No	1	8%
N/A	1	8%
Total	12	100%

PROCUREMENT POLICIES AND REGULATIONS

8. Does your agency permit design-build contracting?

	Number of Responses	Response Ratio
Yes	4	40%
No	6	60%
Total	10	100%

9. Have you used indefinite quantity (task order) contracts?

	Number of Responses	Response Ratio
Yes	7	78%
No	2	22%

	Total	9	100%

10. What types of contractor/consultant reimbursement are permitted (check all that apply)?

	Number of Responses	Response Ratio
Fixed Price	9	90%
Cost Reimbursable	8	80%
Incentive	6	60%
Time and Materials	8	80%
List other that apply	2	20%

11. Do cost-reimbursable contracts require a ceiling?

	Number of Responses	Response Ratio
Yes	5	71%
No	2	29%
Total	7	100%

12. Does your agency have a restriction on maximum allowable overhead?

	Number of Responses	Response Ratio
Yes	3	43%
No	4	57%
Total	7	100%

13. Does your agency have a limit on allowable fees (profits)?

	Number of Responses	Response Ratio
Yes	3	43%
No	4	57%
Total	7	100%

7 Responses

14. What is your policy on intellectual property rights?

	Number of Responses	Response Ratio
Ownership of all products developed under contract	3	33%
Unrestricted license to use of all products developed under contract	3	33%
No policy	0	0%
Other, Please Specify	3	33%

		Number of Responses	Response Ratio
	Total	9	100%

15. Does your agency reimburse consultants and contractors for project management costs?

	Number of Responses	Response Ratio
Yes	9	100%
No	0	0%
Total	9	100%

16. Do you permit sole source acquisition of proprietary software packages (MS Windows, Oracle, etc.)

	Number of Responses	Response Ratio
Yes	11	100%
No	0	0%
Not permitted	0	0%
Total	11	100%

17. Can you acquire off-the-shelf traffic applications software (such as traffic management software, signal control software of dispatch software)?

	Number of Responses	Response Ratio
Yes	11	100%
No	0	0%
Not permitted	0	0%
Total	11	100%

18. Do you use IT industry certifications (such as the Capability Maturity Model (CMM) or ISO 9000) as pre-qualification criteria during the procurement process?

	Number of Responses	Response Ratio
Yes	5	56%
No	4	44%
Not permitted	0	0%

19. Do you incorporate incentives in ITS contracts?

	Number of Responses	Response Ratio
Yes	2	29%
No	5	71%
Total	7	100%

20. Do you incorporate penalties in ITS contracts?

	Number of Responses	Response Ratio
Yes	3	50%
No	3	50%
Total	6	100%

APPENDIX C

ITS PROJECT CATEGORY WORKSHEET

Determining ITS Project Category (Complexity and Risk)

Prepared By: ___________________ **Date:** _______________

Brief Project Description:

____

____

____

____

Which of the following best describes the ***Level of New Development*** for this project?

1. Little to no new software development / exclusively COTS software and hardware based or based on existing proven software and hardware.

2. Primarily COTS software / hardware or existing software / hardware based with some new software development or new functionality added to existing software - evolutionary development.

3. New software development for new system, replacement system, or major system expansion including use of COTS software. Implementation of new COTS hardware.

4. Revolutionary development - entirely new software development including integration with COTS or existing legacy system software. Implementation of new COTS hardware or even prototype hardware.

Answer Number: [ ]

Which of the following best describes the ***Scope and Breadth of Technologies*** for this project?

1. Application of proven, well-known, and commercially available technology. Small scope in terms of technology implementation (e.g., only CCTV or DMS system). Typically implemented under a single stand-alone project, which may or may not be part of a larger multi-phased implementation effort.

2. Primary application of proven, well-known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation (e.g., multiple technologies implemented, but typically no more than 2 or 3). May be single stand-alone project, or may be part of multi-phased implementation effort.

3. Application of new software / hardware along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in

terms of technologies to be implemented. Projects are implemented in multiple phases (which may be category 1 or 2 projects).

4. New software development combined with new hardware configurations / components, use of cutting edge hardware and/or communications technology. Very broad scope of technologies to implement. Projects are implemented in multiple phases (phases may be category 1 or 2 projects).

Answer Number: [ ]

Which of the following best describes the need for ***Interfaces to Other Systems*** for this project?

1. Single system or small expansion of existing system deployment. No interfaces to external systems or system interfaces are well known (duplication of existing interfaces).

2. System implementation includes one or two major subsystems. May involve significant expansion of existing system. System interfaces are well known and based primarily on duplicating existing interfaces.

3. System implementation includes three or more major subsystems. System interfaces are largely well know but includes one or more interfaces to new existing systems / databases.

4. System implementation includes three or more major subsystems. System requires two or more interfaces to new and/or existing internal/external systems and plans for interfaces to "future" systems.

Answer Number: [ ]

Which of the following best describes the need to account for ***Technology Evolution*** during the expected life of this project?

1. Need to account for technology evolution perceived as minor. Example would be to deploy hardware and software that is entirely compatible with an existing COTS-based system. Ramifications of not paying particular attention to standards considered minor. System implemented expected to have moderate to long useful life.

2. Need to account for technology evolution perceived as an issue to address. Example includes desire for interoperable hardware from multiple vendors. Ramifications of not paying particular attention to standards may be an issue, as an agency may get "locked-in" to a proprietary solution. Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have moderate to long life.

3. Need to account for technology evolution perceived as a significant issue. Examples might include implementation of software that can accommodate new hardware with minimal to no modification and interoperable hardware. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.

4. Need to account for technology evolution perceived as major issue. Examples include software that can easily accommodate new functionality and/or changes in hardware and hardware that can be easily expanded (e.g. add peripherals), maintained, and is interoperable. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.

Answer Number: [ ]

Which of the following best describes the need to account for ***Requirements Fluidity*** during development of this project?

1. System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity.

2. System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management.

3. New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processes.

4. System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes.

Answer Number: [ ]

Which of the following best describes the potential impact of ***Institutional Issues*** on this project?

1. Minimal- project implementation involves one agency and is typically internal to a particular department within the agency.
2. Minor- may involve coordination between two agencies. Formal agreements not necessarily required, but if so, agreements are already in place.

3. Significant- involves coordination among multiple agencies and/or multiple departments within an agency or amongst agencies. Formal agreements for implementing project may be required.

4. Major- involves coordination among multiple agencies, departments, and disciplines. Requires new formal agreements. May require new multi-agency project oversight organization.

Answer Number: [ ]

ITS Project Category Score (Answer Number Total): [ ]

ITS Project Category Score	6 -12	12 - 18	18 - 24
Complexity	Straightforward to Moderately Complex	Moderately Complex to Complex	Complex to Extremely Complex
Risk	Low to Moderate	Moderate to High	High to Very High
Category	1 - 2	2 - 3	3 - 4

Determining Your ITS Project Category

Using the table above, determine which of the three (3) ranges your ITS Project Category score falls within. Use your judgment to select the appropriate Category number based on where your score falls within the range. If the score falls towards the lower end of the range, select the lower category in that range. If it falls towards the higher end of the range, select the higher category. If it falls somewhere in the middle, be conservative and select the higher category number. For example, suppose your ITS Project Category Score comes out to 15 which falls directly between 12-18. The suggestion is to be conservative and rank the project as a Category 3, one that is Complex with a High level of risk.

APPENDIX D

AGENCY CAPABILITY WORKSHEET

Determining Agency Capability Level

Prepared By:__________________ **Date:** ______________

Brief Project Description:

____

____

____

____

Which of the following best describes the ***Level of ITS Project Experience*** for your agency's personnel?

1. ITS assigned as part-time job to person with no staff and little to no specific ITS experience.

2. ITS assigned as full-time job with no staff or some part-time staff support. Person assigned has some specific ITS experience with Category 2 or 3 projects. Staff support (if it exists) has little to no ITS experience.

3. Full-time ITS Manager and staff with significant prior ITS experience. Staff support includes system administration, operations, and maintenance responsibilities.

Answer Number: [ ]

Which of the following best describes your agency's ITS *Organizational Experience*?

1. Little to no experience with the possible exception of Category 1 ITS project(s).

2. Experience with at least one Category 2 or greater project.

3. Experience with at least one Category 3 or greater project.

Answer Number: [ ]

Which of the following best describes your agency's *Organizational Structure* for handling ITS project responsibilities?

1. ITS responsibility is not defined. Responsibility housed within organization with other mission or primary responsibility. Responsibility may also be scattered amongst organizational entities with no clear lines of responsibility.

2. ITS responsibility somewhat defined, but not adequately defined. Individual organizational units have ITS responsibility and have their own budgets, management, and priorities; however, there is no definitive linkage between these units. An umbrella ITS organizational unit may exist, but may not have the budgetary authority to effectively manage sub-units.

3. Established organizational unit with budgetary authority and clear ITS responsibilities. Organizational unit ties all ITS responsibilities together and includes a procurement process that supports ITS acquisition (e.g., personnel, policies, and procedures).

Answer Number: [ ]

Which of the following best describes the level of ***Resources*** for ITS within your agency?

1. Little to none. No identifiable ITS budget categories or identification of specific ITS funding within existing organizational units.

2. Some budget resources (e.g., ITS earmark funding) assigned to one or more existing organizational unit(s). Support for personnel, equipment, office space, and training expected to come from organizational unit(s) existing budget.

3. Identifiable budget category set aside for ITS. Budget includes support for all required personnel, support equipment, office space, training, and (if necessary) consulting support.

Answer Number: [ ]

Which of the following best describes the level of ***Management Support*** for ITS and Operations within your agency?

1. Some mid-level management support for ITS/Operations, but little to no interest at top management levels. ITS/Operations not recognized as an agency priority.

2. Strong mid-level management support for ITS/Operations with some interest/involvement at top management levels.

3. Top level management support. ITS/Operations considered an agency priority within its overall mission.

Answer Number: [ ]

Which of the following best describes the level of management *Expectations* for ITS projects within your agency?

1. Not defined or limited to a lower category ITS project that's under consideration for deployment, expansion, or replacement.

2. Expectations exist for a few "special" ITS related projects. Expectations may or may not be realistic depending on if they've been managed properly.

3. ITS/Operations is part of both short and long range planning. Expectations are well defined within actual performance measures. ITS/Operations expectations focus on improvement and not on "status-quo".

Answer Number: [ ]

Agency Level Score (Answer Number Total): [ ]

Agency Level Score	6 -12	12 - 18
Agency Level	1 - 2	2 - 3

Determining Your Agency Capability Level

Using the table above, determine which of the two (2) ranges your Agency Level Score falls within. Use your judgment to select the appropriate Capability Level based on where your score falls within the range. If the score falls towards the lower end of the range, select the lower Capability Level in that range. If it falls towards the higher end of the range, select the higher level. If it falls somewhere in the middle, be conservative and select the higher Capability Level. For example, suppose your Agency Level Score comes out to 15, which falls directly between 12-18. The suggestion is to be conservative and rank your Capability Level as a 2 instead of 3.

APPENDIX E

TASKS 1 AND 2 WORKING PAPER

CONTENTS

BACKGROUND

The successful acquisition of Intelligent Transportation Systems (ITS) has proven to be a challenge for state and local transportation agencies alike. The challenge has been more institutional than technological in nature. Many of the institutional challenges standing in the way of deploying ITS can be attributed to ITS procurement. The American Association of State Highway and Transportation Officials (AASHTO) through the National Cooperative Highway Research Program (NCHRP) has initiated the development of a Guide to Contracting ITS Projects (Project 03-77). The scope-of-work (SOW) associated with the development of this guide is outlined below[1]:

- Task 1 – Review of Transportation and Technology Literature
- Task 2 – Look at Other Industries
- Task 3 – Categorize ITS Projects
- Task 4 – Systems Engineering Process
- Task 5 – Recommend Contract Types
- Task 6 – Prepare a detailed Outline of the Guide
- Task 7 – Prepare the Guide
- Task 8 – Submit Final Report

This working paper provides a summary of the work completed for tasks (1) and (2). This paper also presents results and recommendations that will be carried forward to future tasks.

INTRODUCTION

Tasks (1) and (2) involve the review of relevant transportation and technology literature. It is the intent of these tasks to consider literature relating to both the contracting and deployment of ITS by public transportation agencies, as well as the contracting and deployment of non-ITS information technologies by both the public and private sectors (non-transportation industry). An NCHRP Review Panel is overseeing the entire project. The review panel consists of ITS and contracting professionals from both the public and private sectors. Task (2) requires the delivery of this working paper for review by the NCHRP panel.

As a supplement to the literature review, the research team was asked to conduct a survey of state and local Departments of Transportation to obtain information regarding current ITS procurement and contracting practices.

[1] A detailed SOW for this NCHRP project is included in the proposal.

PROCESS

Several transportation and non-transportation sources were used to identify literature relevant to this project. A special emphasis was placed on non-transportation sources with hopes that other industries would suggest procurement approaches not yet used within the transportation industry. The sources searched for the literature review are presented below:

- Transportation Sources
  - Transportation Research Board
  - JPO Electronic Document Library
  - Institute of transportation Engineers (ITE)
  - ITS America (including State Chapters)
  - State Departments of Transportation
  - American Association of State Highway Officials (AASHTO)
  - ITS Cooperative Deployment Network (ICDN)
- Non-Transportation Sources
  - US Department of Defense
  - State and Federal Procurement Regulations
  - National Association of State Information Resource Executives
  - National Association of State Directors of Administration and General Services
  - The Performance Institute
  - US Department of State
  - National Association of State Purchasing Officials
  - AcqNet
  - US General Accounting Office
  - USDA Graduate School

In order to effectively manage the findings of the literature review, an Access database was developed[2]. References were entered into the database via the form presented in Figure (1). The form structure is based on a format presented in other NCHRP reports.

[2] The Access database can be accessed via the project website at http://www.nchrpproject03-77.com.

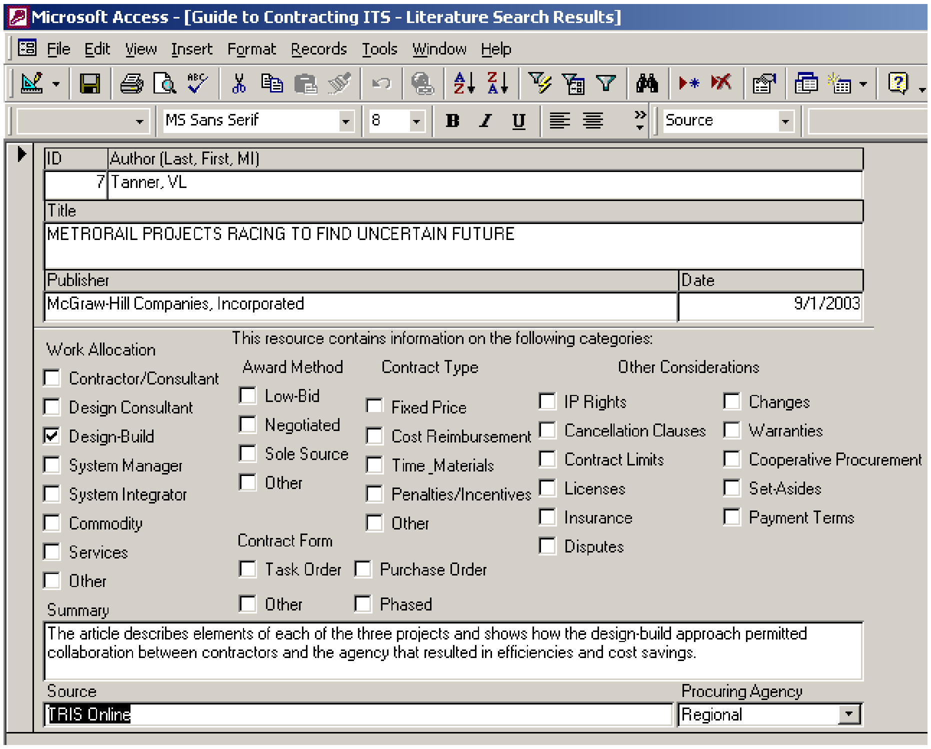

Figure (1) Literature Search Results Form

The form allows for the categorization of each reference based on the *procurement components* the reference addresses. The *procurement components* used to categorize the references are presented in the graphic below.

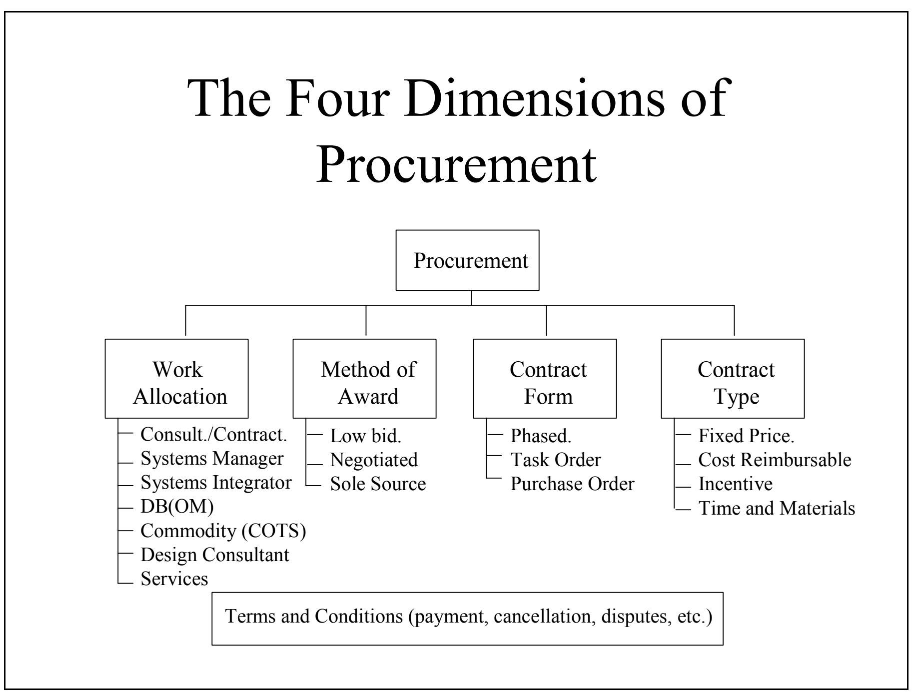

Figure (2)

The procurement components identified in Figure (2) will provide a baseline for analysis throughout the research project.

In anticipation that the literature review would yield a great number of references, criteria were established to identify references that merit in-depth review. The criteria are as follows:

1) Novelty (with respect to the ITS industry)
2) Evaluations of (or Lesson Learned from) Procurement Approaches
3) Consideration of each Procurement Component (outlined earlier in the report)

As mentioned in the Introduction, Task (1) calls for a survey of state and local departments of transportation to obtain information regarding current ITS procurement and contracting practices. The intent of this work is to provide the basic material required by the overall project in order to:

1) Identify unique contracting approaches that might be applicable to ITS procurements.
2) Obtain information related to ITS procurement successes and failures that have been experienced by operating agencies.
3) Attempt to relate the types of procurement currently in use to the characteristics of the project and agency for which they are being applied.

RESULTS

As indicated in Figure 3, the literature review yielded 112 references, and of those 112 references 34 were identified for further review. The breakdown of references is presented in the chart on the following page. All of the references considered are presented in NCHRP format in Appendix A. A list of the references recommended for further review can be found in Appendix B.

There is an extensive bibliography of references describing both ITS and general IT procurements. As might be expected, many of these references address specific experiences without referencing the success or failure of their application. For this reason, they were not included in the list of recommended references. In addition, while there are many more non-transportation related references than transportation (ITS) related references, many were not included because they were not applicable to the ITS industry and the public-sector procurement constraints.

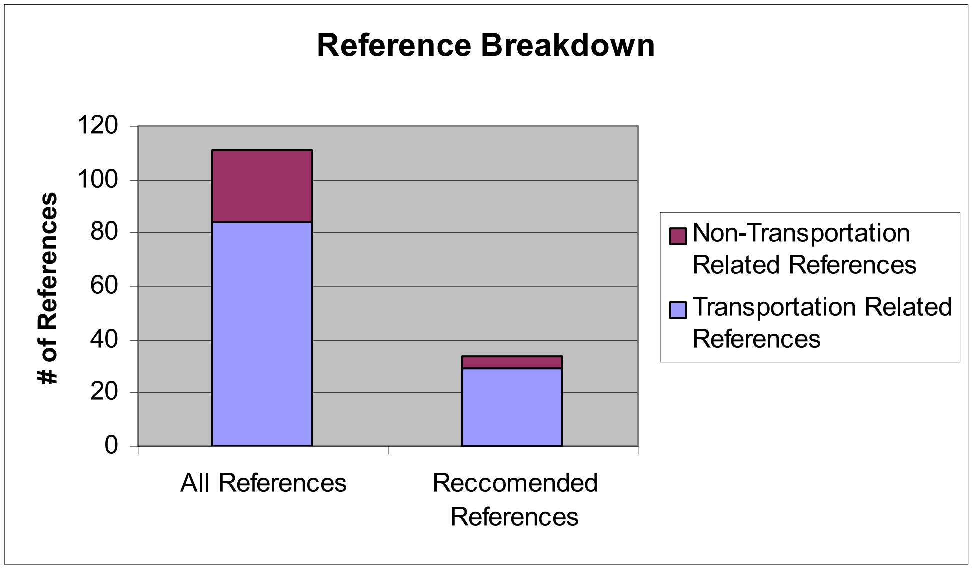

Figure (3) Summary of Literature Search Results

CONCLUSIONS & RECOMMENDATIONS

Based on the results of the literature review, there is a wealth of references addressing the procurement of information technologies. Various innovative contracting methods/ procurement approaches were revealed.

<u>Innovative Contracting Methods/Procurement Approaches</u>
Procurement components are combined to form a procurement approach based on project goals and objectives. Innovative procurement approaches are combinations of [new or established] procurement components to produce a novel procurement approach. The literature review produced both novel procurement components and procurement approaches.

Pre-Qualification and Negotiation

The literature review indicated that the pre-qualification of vendors is becoming increasingly popular among state and local government agencies, the fundamental premise being that the pre-qualification of vendors streamlines the procurement process. Government agencies can use the pre-qualification process to either short-list vendors for a particular procurement or to identify vendors to contract for "indefinite quantities". Through pre-qualification, state and local government agencies are not burdened with reviewing the multitude of responses to solicitations for services and/or goods. Therefore, state and local government agencies can utilize more of their resources on negotiations with respect to the scope-of-work and other considerations. This streamlined process produces a positive effect on the project outcome. Procurement approaches that incorporate this streamlined process include:

- Indefinite Quantities Contracts (IQC)/Indefinite Delivery Indefinite Quantities (IDIQ) Contracts
- The Information Technology Omnibus Procurement (ITOP) Program
- Invitation to Negotiate (ITN)

Invitation to Negotiate (ITN)

The ITN procurement process/approach used throughout the State of Florida provides a novel approach for procuring ITS. An overview of the activities involved in the ITN procurement approach is outlined below:

- Step 1) FDOT develops and releases an ITN.
- Step 2) Interested vendors respond to the ITN.
- Step 3) Interested vendor responses are reviewed and either ranked or included in a next iteration of the ITN scope. The next iteration of the ITN scope will be only distributed to a "short-list" of best-qualified vendors based on the responses to the initial ITN.
- Step 4) Once the ITN scope has been finalized and re-distributed, then vendors are ranked according to their final responses.
- Step 5) The highest ranked vendor is selected for the procurement.

The ITN procurement approach has been chosen for several ITS deployments by the Florida Department of Transportation. FDOT utilizes the ITN procurement approach when they intend to procure technologies that are at their infancy stage of development. This is done in recognition of the fact that procurement of "cutting edge" technologies is hard to scope and therefore, introduces a lot of risks. The ITN procurement approach mitigates these risks.

Performance-Based Contracting

Performance-based contracting is a good option for select ITS procurements. A performance-based contract specifies the final outcome of a task or project and leaves the method used to reach the final outcome up to the contractor/consultant. The task or project objectives are translated into measurable/quantifiable specifications. Successful completion of the task or project is gauged by these measurable/quantifiable specifications. The use of performance-based contracts produces the following benefits[3]:

- Enhances relationship between contractor and client
- Motivates the development and implementation of new ideas
- Innovative ideas, methods to keep quality high while reducing cost
- Direct relationship between performance and pay
- Creates greater ownership, commitment and accountability by the contractor
- Provides for greater management attention to the project
- Improves project execution, data collection and management
- Contractor assumes some associated risks

[3] Based on project reference ID: 53, *Guideline to Managing Performance Based Operations and Maintenance Contracts*.

Design-Build

The design-build work allocation method has long been identified as a tool for successful procurement of ITS as several innovative permutations and variations of the design-build work allocation method have been established. For instance, the design-integration work allocation method is gaining popularity in other industries.

The Connecticut Department of Transportation (ConnDOT) utilized a unique variation of the design-build work allocation method to procure an advanced traffic data collection system. ConnDOT inserted a proof step in between the design and build steps. The proof step required the contractor to develop and test a prototype of the proposed system. Additionally, the contractor was required to conduct a system demonstration test. The proof step identified problems areas sooner, which made field-testing easier. The test also reduced the risk of incurring multiple change orders during the integration phase of the project.

References dating back to the early 1990s recognize the challenge of procuring ITS and have suggested alternative procurement methods such as design-build. Since alternative procurement methods have long been identified and the challenge of procuring ITS still exists today, then it can be surmised that the present challenge in procuring ITS can be attributed to the institutionalization of these alternative procurement methods at state and local transportation agencies. Most of the research done to date on this topic has focused on identifying alternative procurement methods. Now that alternative procurement methods have been identified and tested, it is now time to re-focus the industries research efforts to the institutionalization of these alternative procurement methods. The first step to institutionalization is education.

Options, with respect to procurement approaches, are constrained by federal and state laws, grant terms and agency regulations and practices. The ultimate goal of this resource should be to provide a systematic approach to identify and consider relevant federal and state laws, grant terms and agency regulations and practices when planning to procure ITS.

APPENDIX F

TASK 3 WORKING PAPER

TABLE OF CONTENTS

BACKGROUND

The successful acquisition of Intelligent Transportation Systems (ITS) has proven to be a challenge for state and local transportation agencies alike. The challenge has been more institutional than technological in nature. Many of the institutional challenges standing in the way of deploying ITS can be attributed to ITS procurement. The American Association of State Highway and Transportation Officials (AASHTO) through the National Cooperative Highway Research Program (NCHRP) has initiated the development of a Guide to Contracting ITS Projects (Project 03-77). The scope-of-work (SOW) associated with the development of this guide is outlined below[1]:

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- Task 7 – Prepare the Guide
- Task 8 – Submit Final Report

This working paper provides a summary of the work completed for task (3). This paper also presents results that will be used as the basis for the work in tasks (4) and (5). This is considered a draft deliverable that will be finalized based on input received from the NCHRP panel overseeing this project.

INTRODUCTION

The purpose of task 3 is to categorize ITS projects based on a number of factors[2] including complexity of the project, the level of new development required, the scope and breadth of technologies involved, the amount of interfacing to other systems, the likelihood of technology evolution, and the fluidity of the requirements. Together, these factors influence the level of risk associated with an ITS project. Project risk may be defined in terms of schedule, quality, cost, or requirements risks[3]. These risks can increase or decrease significantly based on the above factors and their associated characteristics. For an ITS project to be successful, it is important that the procurement process take into account the level of risk involved with a project. Thus, a thorough understanding of these factors, their associated characteristics, and their influence on the overall risk associated with ITS projects is very important.

Table 1 in the detailed SOW for this NCHRP project provided a starting point for identifying generic ITS project categories along with the factors and characteristics that support their definitions ***(see Table 1 on following page)***. The "starting point" included

[1] A detailed SOW for this NCHRP project is included in the proposal.
[2] These are the original factors as listed in the NCHRP Project 3-77 Request for Proposal.
[3] *Intelligent Transportation System (ITS) Software Integration Project Risk Assessment and Mitigation*, 2002, Yermack, Larry, and Iserson, Andy, prepared for AASHTO.

Table 1. ITS Project Categories and Associated Characteristics

	Category 1	Category 2	Category 3	Category 4
Complexity	Simple	Moderately complex	Complex	Extremely complex
Level of New Development	Little to no new software development / exclusively COTS based or based on existing proven software	Primarily COTS software or existing software based with some new software development or new functionality added to exisitng software - evolutionary development	New software development for new system, replacement system, or major system expansion including use of COTS software	Revolutionary development - entirely new software development including integration with COTS or existing legacy system software
Scope & Breadth of Technologies	Application of proven, well known, and commercially available technology. Small scope in terms of technology implementation	Primarily application of proven, well known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation	Application of new software along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in terms of technologies to be implemented	New software development combined with new hardware configurations/components, use of cutting edge comm technology. Very broad scope of technologies to be implemented
Interfaces to Other Systems	No interfaces to external systems or system interfaces are well known (duplication of existing interfaces)	System interfaces are well known and based primarily on duplicating existing interfaces	System interfaces are largely well known but include interfaces to new existing systems/databases	System requires interfaces to both new and existing internal/external systems and plans for interfaces to "future" systems
Technology Evolution	Little to no impact on system in terms of technology evolution	Little to minor impact on system in terms of technology evolution. May involve only upgrades of COTS software	Technology evolution likely to have moderate to signifcant impact and must be adequately accounted for in system design	Technology evolution very likely with potential major implications on system to be implemented
Requirements Fluidity	System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity	System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management	New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processess	System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes
Overall Risk	Low	Moderate	High	Very high
General ITS Project Example	Expansion of existing systems…adding additional field devices (CCTV, DMS, etc).	Implementation of computerized signal system.	Replacement of existing TMC software with the addition of new system functionality.	New TMC system implementation including field devices, interfaces to internal/external systems, etc.

four ITS project categories ranging from "low" overall risk for a Category 1 project to "very high" overall risk for a Category 4 project. Table 1 also included a brief general description of a system implementation that might represent a particular ITS project category.

The intent of the work on task 3 to date has been to validate Table 1 as an appropriate categorization of ITS projects. Even more important, an effort was made to validate the factors and their associated characteristics as they will ultimately be most useful in selecting the procurement components[4] that can best address the overall risk associated with and ITS project.

[4] Recall that the four dimensions of procurement that were identified in tasks (1) and (2) include: Work Allocation, Method of Award, Contract Form, and Contract Type.

PROCESS

The ITS project category validation was a subjective process that started with collecting a diverse cross section of real-world ITS project examples. Information was collected on over 200 ITS projects from the year 2000 to present, the sources of which were primarily AASHTO and US DOT operations and ITS web sites. Each project was given a cursory review within the context of the previously defined Categories in Table 1. The purpose of this initial cursory review was to (1) find a short list of examples that represented the previously defined Categories and (2) to determine if there were projects that didn't seem to fit within these Categories, hence requiring the addition of a category. A short list of 50 projects was developed that represented various types[5] of the following systems.

- Arterial Management Systems
- Freeway Management Systems
- Transit Management Systems
- Emergency Management Systems
- Electronic Toll Collection Systems
- Electronic Fare Payment Systems
- Traveler Information Systems
- Weather Systems
- Rural Transit Mobility
- Rural Traffic Management
- Operations & Maintenance
- CVO/CVISN Systems

A matrix was then developed to ensure that there was a good distribution of projects across categories and system types, the rationale being that the ITS project categories, factors, and associated characteristics should, to the extent possible, be representative of many types of systems and not just, for example, freeway management systems. Next, at least four projects were selected that represent each ITS project category. Projects were also selected to represent the wide variety of system types. A total of 19 project examples were ultimately selected and an effort was made to describe each based on the factors and associated characteristics in Table 1. In this step, additional detailed information was sought for the ITS project examples through transportation agency or project specific web sites. The results of this effort, including an updated version of Table 1, are discussed in the next section.

RESULTS

The table in Appendix A maps the 19 project examples to the factors and associated characteristics in Table 1. This mapping process revealed that the ITS project categories, factors, and associated characteristics originally developed for Table 1 under the statement of work, were largely on the mark. The exceptions, which have resulted in modifications to Table 1, are as summarized as follows:

---

[5] System types were based on the organization of US DOT's ITS Projects Handbook.

- **ITS Project Factor Modification.** A new ITS Project Category factor called "Institutional Issues" has been added. As ITS projects were reviewed for inclusion in the table in Appendix A, it became clear that there was an important factor missing that, while non-technical in nature, has a great deal of influence on the difficulty associated with implementing an ITS project. The "Institutional Issues" factor is intended to help describe an ITS project in terms of, for example, the need for new agreements (either intra or inter agency Memorandum of Understanding), modifications to existing business models, working relationships, or operational procedures, and a general need to work with non-traditional partners.

- **Modifications to the Factor Characteristics.** The following key modifications have been made to the characteristics that describe the factors:

    - The characteristics of the factor "Scope and Breadth of Technologies" now include the concept of "phasing". In terms of scope, an ITS implementation may be done as a single stand-alone project. At the opposite end of the spectrum, a very large ITS project may be divided up into multiple phases. The degree to which phasing is used will impact an agency's procurement strategy.

    - The characteristics of the factor "Technology Evolution" have been expanded and clarified. In preparing the Table in Appendix A, this was the most difficult factor in trying to relate to a real-world ITS project and it became abundantly clear that the characteristics describing this factor in Table 1 were too vague. Task 3 of the RFP for NCHRP Project 3-77 describes this factor as "likelihood of technology evolution." The fact is that, with any category of ITS project, the probability of technology evolution is 100%. Technology installed today will "evolve" within a matter of weeks or months depending on what it is. Quite often, technology specified in procurement documents is outdated by the time it actually gets installed (or in some cases by the time the RFP hits the streets). Standards are often identified as a way to account for technology evolution; however, in some cases the rapid rate of technical progress leaves formal standardization efforts slow to catch up if the standards are formulated by relatively slow moving and deliberate standard-setting bodies[6]. The characteristics describing the Technology Evolution factor have been modified to describe a subjective perspective of the perceived impact of Technology Evolution on software and hardware deployed under an ITS project. In this perspective, technology evolution is perceived by the deploying agency or organization as being a relatively minor issue for a Category 1 ITS project whereas it becomes an increasingly bigger issue as the category increases.

[6] Association for Information Systems (AIS)

- The factor characteristics in Table 1 were very much software oriented. They have been modified to include a hardware orientation as well.

All of these modifications are reflected in an updated ITS Project Category Table ***(see Table 2 on the following page)***. Following is a summary of the descriptive characteristics for the category factors that have been updated, as appropriate, from what was included in the original statement-of-work.

- **Complexity.** The characteristics that describe this factor provide a succinct indication of the level of difficulty associated with implementing an ITS project in a particular category. The level of difficulty is directly related to subsequent factors and their associated characteristics. The description of "Simple" for a Category 1 project in Table 1 was changed to "Straightforward" in Table 2.

- **Level of New Development.** The characteristics that describe this factor describe the level of new software development and hardware deployment associated with an ITS project implementation. The level of new software development typically is the riskiest factor associated with an ITS project.

- **Scope and Breadth of Technologies.** The characteristics that describe this factor include: (1) the level of technology implementation; and (2) the scope of technologies implemented by an ITS project. Levels of technology implementation range from the application of proven, well-known, and commercially available technology to the use of cutting edge technology. Scope refers to the range of technology implemented. For example, the scope associated with a Category 1 ITS project might involve installation of new field devices such as CCTV cameras that will be controlled by an existing traffic management center. On the other end of the spectrum, the scope associated with a Category 4 ITS project might involve, for example, construction of a new traffic management center building, installation of field devices (e.g., detectors, CCTV cameras, variable message signs, vehicle probe technology based on cellular geo-location), new central control system software with entirely new functionality, system interfaces to transit, public safety, and commercial vehicle systems and databases, implementation of wire-line and wireless communications technologies, etc. Another scope related characteristic that was added involves the concept of phasing. Category 1 and 2 projects may be done as a single stand-alone project involving only one phase. Due to the complexity of category 3 and 4 projects, they typically involve multiple phases, which is consistent with good practice (good practice being to break up large projects into small manageable pieces). Category 1 and 2 projects may actually be part of phases under category 3 and 4 projects. This is significant in that a category 3 and 4 project may use a diverse mix of procurement components as opposed to a "one-size fits all" approach.

Table 2. Updated ITS Project Categories and Associated Characteristics

	Category 1	Category 2	Category 3	Category 4
Complexity	Straightforward	Moderately Complex	Complex	Extremely Complex
Level of New Development	Little to no new software development / exclusively COTS software and hardware based or based on existing proven software and hardware.	Primarily COTS software / hardware or existing software / hardware based with some new software development or new functionality added to exisitng software - evolutionary development.	New software development for new system, replacement system, or major system expansion including use of COTS software. Implementation of new COTS hardware.	Revolutionary development - entirely new software development including integration with COTS or existing legacy system software. Implementation of new COTS hardware or even prototype hardware.
Scope & Breadth of Technologies	Application of proven, well known, and commercially available technology. Small scope in terms of technology implementation (e.g., only CCTV or DMS system). Typically implemented under a single stand-alone project which may or may not be part of a larger multi-phased implementation effort.	Primarly application of proven, well known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation (e.g., multiple technologies implemented, but typically no more than 2 or 3) . May be single stand-alone project, or may be part of multi phased implementation effort.	Application of new software / hardware along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in terms of technologies to be implemented. Projects are implemented in multiple phases (which may be category 1 or 2 projects).	New software development combined with new hardware configurations/components, use of cutting edge hardware and/or communications technology. Very broad scope of technologies to implemented. Projects are implemented in multiple phases (phases may be category 1 or 2 projects).
Interfaces to Other Systems	Single system or small expansion of existing system deployment. No interfaces to external systems or system interfaces are well known (duplication of existing interfaces).	System implementation includes one or two major subsystems. May involve signicant expansion of existing system. System interfaces are well known and based primarily on duplicating existing interfaces.	System implementation includes three or more major subsystems. System interfaces are largely well know but includes one or more interfaces to new existing systems / databases.	System implementation includes three or more major subsystems. System requires two or more interfaces to new and/or existing internal/external systems and plans for interfaces to "future" systems.
Technology Evolution	Need to account for technology evolution perceived as minor. Example would be to deploy hardware and software that is entirely compatible with an existing COTS-based system. Ramifications of not paying particular attention to standards considered minor. System implemented expected to have moderate to long useful life.	Need to account for technology evolution perceived as an issue to address. Example includes desire for interoperable hardware from multiple vendors. Ramifications of not paying particular attention to standards may be an issue as an agency may get "locked-in" to a proprietary solution. Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have moderate to long life.	Need to account for technology evolution perceived as a significant issue. Examples might include implementation of software that can accommodate new hardware with minimal to no modification and interoperable hardware. Ramifications of not using standards based technolgy are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extentable useful life.	Need to account for technology evolution perceived as major issue. Examples include software that can easily accommodate new functionality and/or changes in hardware and hardware that can be easily expanded (e.g. add peripherals), maintained, and is interoperable. Ramifications of not using standards based technolgy are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extentable useful life.
Requirements Fluidity	System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity.	System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management.	New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processess.	System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes.
Institutional Issues	Minimal- project implementation involves one agency and is typically internal to a particlar department within the agency.	Minor- may involve coordination between two agencies. Formal agreements not necessarily required, but if so, agreements are already in place.	Signficant- involves coordination among multiple agencies and/or multiple departments within an agency or amongst agencies. Formal agreements for implementing project may be required.	Major- involves coordination among multiple agencies, departments, and disciplines. Requires new formal agreements. May require new muli-agency project oversight organization.
Overall Risk	LOW	MODERATE	HIGH	VERY HIGH

- **Interfaces to Other Systems.** The characteristics that describe this factor are based on the number of major subsystems as well as the number and complexity of existing and new system/database interfaces that will be included in an ITS project implementation. This ranges from no major subsystems and interfaces (or a duplication of well-known existing interfaces) for a Category 1 ITS project to a Category 4 ITS project that might include multiple major subsystems and multiple interfaces to new and existing systems both internal and external to the implementing agency as well as planning for future interfaces that don't yet exist.

- **Technology Evolution.** The characteristics that describe this factor are based on an agency's perceived need to account for the evolution of technology. This "perceived need" comes into play more for category 1 and 2 projects. For example, an agency may consciously decide to implement CCTV camera hardware and control software that is compatible with their existing system. While this technology is evolving, an agency's perceived need to take this in account may be influenced by having to wait for the emergence of CCTV standards and the associated vendor equipment that meets the standards. In this case, the agency will likely opt to deploy equipment based on their existing equipment. At some point in the future, as standards based CCTV equipment comes to market, the agency may decide to make changes to their central control system software so that they can easily deploy standards based hardware from different vendors in the future. When it comes to category 3 and 4 projects, the need for taking into account technology evolution should be based less on the perceived need and more on actual need. The reality is that the agency really doesn't have a choice but to take technology evolution into account. For example, an ITS project that involves implementation of a mobile data communications system in conjunction with automatic vehicle location for service patrol vehicles will be impacted significantly by rapid changes in wireless communications technology. Technology evolution, in this case, is an actual need since not accounting for it can have a major impact on the long-term viability and ultimate success of the system.

  In addition to the agencies perceived need to account for changing technology, it is helpful to think of technology evolution in terms of the expected usable life of a system, its subsystems, components, and underlying technology (both hardware and software). Characteristics used to describe useful life under this factor include the terms "short", "moderate", "long", and "extendable". From a technology standpoint, short could be considered 3-5 years; moderate could be considered 5-7 years; and long could be considered 7-10+ years. The term "extendable" implies that a particular technology or component's life may be extended at the end of its initial life. It is, however, difficult to apply the concept of expected useful life to an overall system. Therefore, these terms are used in Table 2 to describe three separate components of an ITS project: field devices, center-based hardware, and control system software, all of which can be expected to have different expected useful lives.

- **Requirements Fluidity.** The characteristics that describe this factor are based on how well requirements are understood and defined upfront along with the likelihood of requirements changes during the ITS project implementation. The characteristics also describe the level of requirements management that may be necessary based on the category.

- **Institutional Issues.** The characteristics that describe this factor are intended to help describe an ITS project in terms of, for example, the need for new agreements (either intra or inter agency), modifications to existing business models, working relationships, or operational procedures, and a general need to work with non-traditional partners. Not addressing these issues in an ITS Project can lead to the failure of a technically successful implementation.

- **Overall Risk.** This is a brief description of the overall risk associated with a category and is based on all of the prior factors and their characteristics. The Overall Risk ranges from "low" for a Category 1 ITS Project to "very high" for a Category 4 ITS project.

CONCLUSIONS & RECOMMENDATIONS

One drawback to Table 2 is that it emphasizes only the ITS project specific factors and characteristics associated with a project implementation. While an understanding of these project specific factors is critical to selecting the best procurement approach, there are a number of non-project related factors that will influence the optimal mix of procurement components applied on a successful ITS implementation. Figure 1 identifies the additional factors that will influence selection of an appropriate procurement strategy. The factors in the middle box on the left side of the diagram are those that are included in Table 2 and have received the attention of this task to date. The "Agency" box and "Environment" box identify additional non-project specific factors that will directly influence procurement decisions. These additional factors span all ITS Project Categories and are summarized as follows:

- **Agency Factors.** These factors and associated characteristics generally pertain to an agency's (or organization's) capability to successfully manage an ITS project implementation. Agency factors include:

  – **Personnel.** It is critical that an agency, to the extent possible, have the necessary personnel with the appropriate skills to oversee an ITS project implementation (ideally these are in-house personnel). Getting agency personnel actively involved in the design, development, implementation, operations, and maintenance is important to a successful ITS implementation, but this active involvement takes considerable amount of time and effort. These individuals might include (but is certainly not limited to) system administrators, maintainers, operators, electrical engineers, software expertise, and even contracting and purchasing personnel that can help put together the best mix of procurement components together.

Agencies can also take advantage of expertise of Information Technology (IT) personnel either within or outside their departments. This expertise can take the form of technical expertise (e.g., hardware, software, communications) or even IT procurement expertise. While coordination with IT staff is advocated, relinquishing the authority for doing technology procurements (e.g., moving responsibility for procuring ITS related hardware, software, and communications from the DOT to another State department responsible for IT) is not necessarily recommended.

- **Experience.** An agency's experience with implementing ITS projects will have an impact on an ITS implementation. This doesn't imply that agencies who have implemented dozens of ITS projects do not experience any problems. However, they do have a feel for pitfalls to avoid and generally have had some time to put together a mix of in-house and consultant personnel that have the skills and experience to improve the success of an ITS implementation.

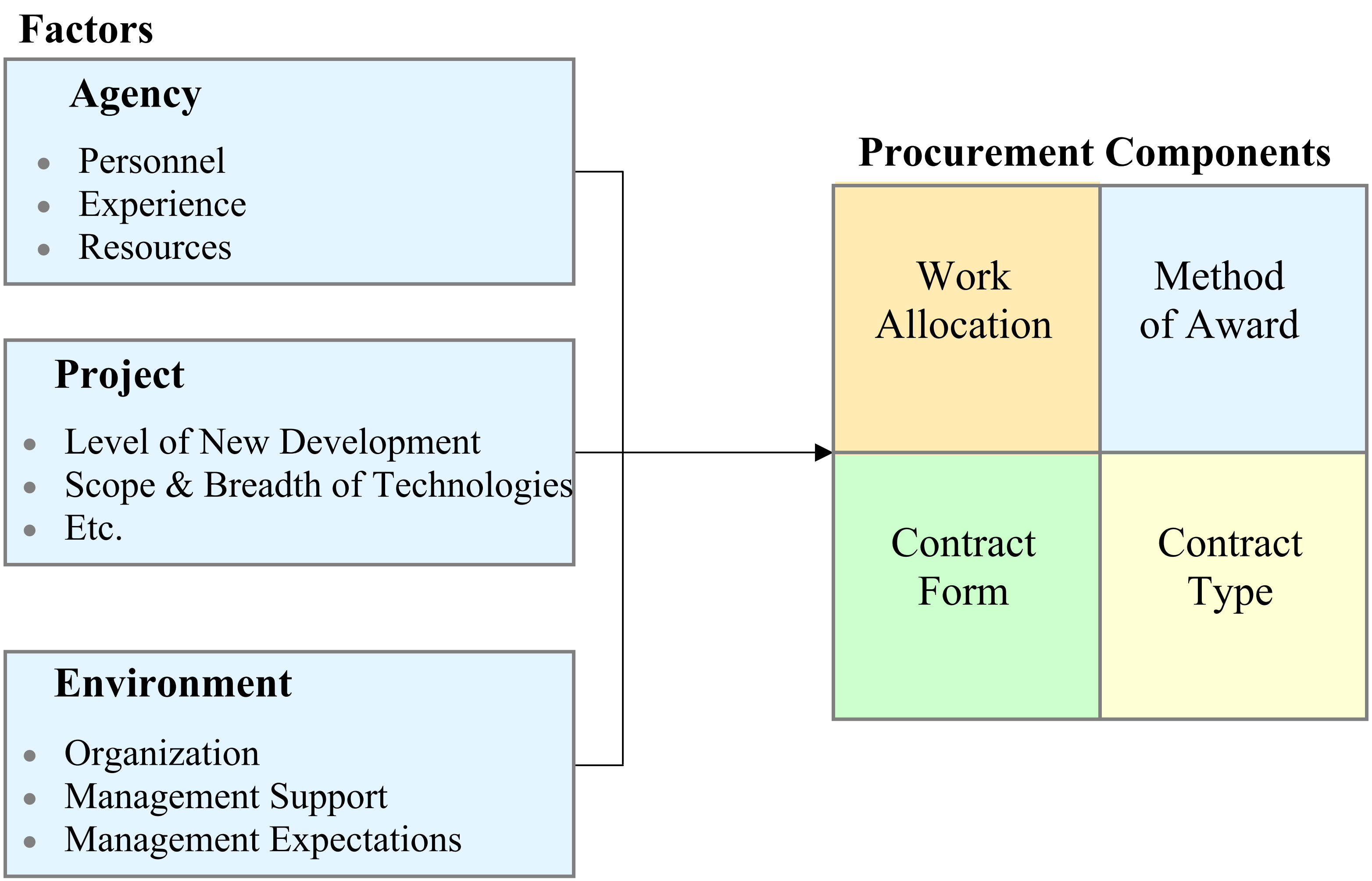
- **Resources.** An agency needs many types of resources to achieve a successful ITS implementation. Personnel, funding, office space and equipment, and training represent just a few examples of these important resources. Obviously funding is important, but if funds are available, personnel resources are perhaps the most critical.

- **Environmental Factors.** These factors and associated characteristics generally pertain to the overall environment or organizational culture within which an ITS project is implemented. Factors related to environment include:

  - **Organization.** Whether or not an agency is organized to support ITS projects can be critical to implementation success. While there may be aspects of an ITS implementation that are handled within an existing organizational structure, there may be a need to create new teams or offices devoted to, for example, ITS Operations, Development, Integration, etc. The more involved in ITS an agency gets, the more important it is for an agency to be organized to support developing and deployed systems, especially over the long-term.

  - **Management Support.** Upper management, including agency leadership, must buy-in to an ITS/operations philosophy in order for any ITS project to succeed. At the same time, intimate involvement in an ITS initiative by upper management may require changes in various aspects of a project implementation; hence the need for maintaining flexibility in procurement approaches.

Figure 1. Factors Influencing Procurement

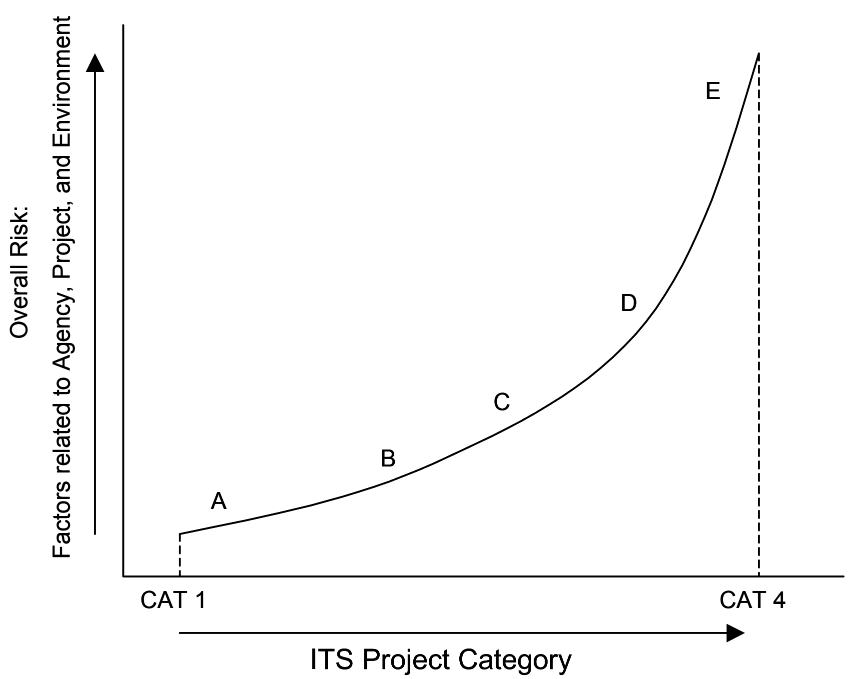


– **Managing Expectations.** This factor can make or break an ITS project. Managing expectations means not over promising, especially with regard to functionality or the time frame under which functionality will be deployed.

It is apparent then that the overall risk of an ITS project is really based on a combination of all three subsets of factors included in Figure 1, Agency Factors, Project Factors, and Environmental Factors. ***Figure 2*** shows that as the ITS Project Categories go from straightforward (Category 1) to extremely complex (Category 4), the overall risk based on Agency, Project, and Environmental factors increases (note that the curve representing this relationship is illustrative only). The combination of all of these factors, together with the concept of ITS categories, may be used to determine the appropriate mix of procurement components. This mix of components is represented by the box divided into four quadrants (Work Allocation, Method of Award, Contract Form, and Contract Type) on the right side of Figure 1. This mix of components as represented by the box on the right side of Figure 1 is analogous to the letters A,B,C,D,E along the curve of Figure 2. For example, the point on the curve represented by letter A may represent the following mix of procurement components based on a relatively straightforward low risk ITS project:

- Work Allocation: Contractor
- Method of Award: Low Bid
- Contract Form: Phased
- Contract Type: Fixed Price

Figure 2. ITS Project Category vs. Overall Risk



However, the point on the curve represented by letter E would represent and entirely different mix of procurement components based on an extremely complex high risk ITS project. This mix might be as follows:

- Work Allocation: Design-Build
- Method of Award: Best Value with Negotiations
- Contract Form: Task Order
- Contract Type: Fixed-Price with Incentives

The letters are illustrative only, however, the intent is to show that the mix of procurement components will vary as appropriate to address the complexity and risk associated with an ITS implementation.

It is worth noting that describing an ITS project by its associated “Category” is not in itself inherently useful. While Table 2 has clearly delineated lines separating the four categories, the reality is that the lines separating categories can be blurred. For example, a project may have characteristics that equate to some factors being associated with a Category 1 project, some with a Category 2, and perhaps one with a Category 3 or 4. The problem then becomes a matter of choosing a category. However, the category is not, by itself, important. What is important are the actual factors and associated characteristics. It is recommended that the factors and associated characteristics in Table 2, along with the non-project specific factors and characteristics that have been identified, be used as the basis for carrying out work under tasks 4 and particularly 5, where contract types are to be recommended. The results of task 3 will also serve as the basis for providing the input to a prototype of a web-based tool that will assist an individual in determining the appropriate mix of procurement components (output) based on their project, agency, and environment.

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
CCTV system expansion on I-85 and I-95 in SC	Category 1	FMS	Straightforward	Implementation of commercially available hardware and software based on existing system	Scope and breadth limited in that project included installation of CCTV cameras (based on previously used hardware). Stand-alone project was done in a single phase.	Field hardware interfaced to existing TMCs. No new system interfaces.	Compatible (e.g. same vendor) CCTV system hardware / software is used. Perceived need to account for technology evolution is minor.	Since system install based on CCTV technology previously used, requirements were well understood.	minimal	LOW	
Install additional transponder readers on Belt Parkway, Van Wyk, Cross Island, etc. (TRANSMIT)	Category 1	FMS/ETC	Straightforward	This project was based on installing additional existing commercially available transponder reader hardware. Software for processing tag data had already been developed.	Scope and breadth limited in that project involved installing additional field devices [based on previously used hardware and typical field installations of reader devices mounted on existing structures]. Single phase implementation.	Field hardware interfaced to existing data collection / processing system.	Readers installed based on existing / previously used specifications to read existing toll-tags. Perceived need to account for technology evolution is minor.	Since reader installations are based on previously used technology and typical field installations, requirements were well understood.	minimal - all installs were in NY State, some coordination required between NY State DOT and NYC DOT	LOW	Could be future technology evolution issues based evolving 5.9 GHz DSRC standards.
Install 8 RWIS sites in Anchorage	Category 1	WS	Straightforward	Initital installation (Phase 1) in Anchorage Bowl area involved COTS road weather information system including hardware and software.	Scope and breadth limited to installing commercially available hardware and software for 8 RWIS sites. This was the first phase of a multi-phase initiative.	Installation of stand-alone RWIS…no interfaces to other system(s) for initial install.	According to manufacturer, RWIS installed based on "open-architecture" and field equipment NTCIP-ESS compliant.	Commercial RWIS have been available for many years. Requirements for typical installations of these sytems are well understood.	minimal	LOW	Phase 2 included expansion of sites statewide with remote sites having difficult implementation issues (e.g., power & comm). Phase 2 also included participation in AURORA[1]. Phase 2 would likely be considered a Category 2 project.
Place 75 portable DMS in Metro Boston Area	Category 1	FMS	Straightforward	Purchase and installation of commercially available portable Dynamic Message Sign hardware and software.	Scope limited to purchase of specific hardware and software. Portable DMS placed at strategic decision points within Metropolitan Boston Area.	Purchase and install of stand-alone portable DMS…no interfaces to other systems.	Compatible (e.g. same vendor) DMS hardware / software is used. Perceived need to account for technology evolution is minor.	Commercially available portable DMS have been available for many years. Requirements for this equipment and its uses are well understood.	minimal	LOW	Today, technology evolution with regard to DMS can be somewhat addressed through specifciation of NTCIP DMS standards.

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Install closed-loop signal system covering 75 intersections in Kinston, NC	Category 2	AMS	Moderately Complex	Purchase and installation of commercially avialable signal control hardware and closed-loop control software. Project included installation of a few CCTV cameras as well.	Predominately installation of proven, well known, and commercially available hardware and software. Incorporation of both signal control and CCTV camera systems. Single phase implementation.	Control software interface to field devices COTS-based. No interfaces to other non-signal control systems.	Compatible (e.g. same vendor) hardware / software is used. Standards based traffic controllers implemented. Possible technology evolution issues if future desire to operate in a non closed-loop environment (e.g., adaptive control).	Requirements for closed loop signal control are well understood and there are a variety of COTS hardware/software systems available to meet these requirments. Inclusion of CCTV camera monitoring requires a bit more attention to requirements gathering.	minor - some coordination between NC DOT and City of Kinston, but predominately a NC DOT project	MODERATE	
Install smart work zone systems at 5 Interstate work zones in Arkansas	Category 2	FMS/IMS	Moderately Complex	Purchase and installation of commercially available Automated Work Zone Information Systems (AWIS) from multiple vendors.	Predominately installation of relatively proven commercially available hardware and software. Single phase implementation, but involved separate construction contracts.	Each AWIS was installed as stand-alone system (by requirement). No interfaces to other systems or a central control system in a Traffic Operations Center.	Compatible (e.g. same vendor) hardware / software is used for each AWIS site. Perceived need to account for technology evolution is minor. Likely issue is that equipment software implemented by different vendors is incompatible.	Requirements generally well understood. Additional attention to requirements based on fact that no TOC in Arkansas to monitor/control AWIS.	minor - design, installation, and operation of smart zone system made responsibility of construction contractor.	MODERATE	
Expand FMS/EOC in Baton Rouge, LA	Category 2	FMS	Moderately Complex	Expansion of FMS field equipment and installation of fiber optic backbone communications. Field equipment (e.g., CCTV, detectors, DMS, etc.) based on previously used equipment and exisiting COTS-based central control software.	Wide array of field hardware deployment (CCTV, DMS, detectors, HAR, etc.) and fiber optic communications over 15 miles of I-10 in urban area. Field hardware technology well known and commercially available. Multi-phase implementation.	Interfaces between field equipment and central software based on previously used hardware and central software. No interfaces to other systems.	Compatible hardware (based on previously used specifications) / software (based on existing central software) used during implementation. COTS standards based central software capable of controling multiple ITS field devices.	Requirements generally well understood based on installation of typical FMS field equipment. Additional attention to requirements based on transition to fiber backbone for field device communications.	minimal- expansion of existing jointly operated FMS/EOC in which may institutional issues already resolved.	MODERATE	
Install software that allows communication with multiple existing portable DMS in North Dakota	Category 2	RTM/RTIS	Moderately Complex	Implementation of software that will allow control of DMS hardware from several different vendors. Involved examination of COTS software that could be used for this purpose.	Software implementation for control of portable DMS used throughout state in winter for traveler information and summer for construction. Scope and breadth limited to single software application for controlling similar field hardware. Single phase implementation.	No interfaces to other systems involved.	Not an issue if portable DMS from same vendor(s) continue to be purchased. Could become an issue if DOT would like to use DMS from another vendor that is not currently used. DMS standards issues a consideration.	Requirements well understood. If COTS application does not work and new software is developed, requirements management becomes more of an issue.	minimal	LOW-MODERATE	

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Maintain ITS Equipment in Virginia I-81 Corridor	Category 2	O&M	Moderately Complex	No new development. Performance based ITS field equipment maintenance support services.	Scope limited to field ITS hardware failure maintenance and preventive maintenance. Technologies include DMS, CCTV cameras, HAR, RWIS stations, etc.	No interfaces to other systems involved.	Unlikely to be an issue as project involves maintenance of existing field equipment.	Requirements unlikely to change over time; however, developing initial performance requirements can be challenge.	minor - use of performance specifications of prescriptive specifications. Requires good data collection procedures for measuring outcomes agains goals	MODERATE	
Integrate operations of fixed-route and demand-response paratransit systems in Brownsville, TX	Category 3	TMS	Complex	COTS based applications of AVL and dispatching / transit management center software and transit fleet hardware.	While transit operations are relatively small, the scope and breadth signficant including software and hardware to implement AVL, center to fleet communications, passenger counting, dispatching, and real-time web-based transit information. Multi-phase implementation.	Involves integration of fixed route and demand-response paratransit systerms. Other interfaces to non-transit related transportation and public safety systems are under consideration.	Technology evolution a significant issue as project involves signficant software, hardware, and mobile communication issues.	Transit management system requirements are well understood and there are COTS based applications available. However, project scope, and potential for technology evolution require early definition of requirements. Formal requirements management a consideration do to potential for evolving requirements.	Significant - project involves combing operations of fixed route and paratransit into centralized transit operations center. Interfaces to other public safety systems may require formal agreements.	HIGH	

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Develop statewide transit trip planning web-site that covers Washington and Oregon	Category 3	TIS/TMS	Complex	Possible combination of existing COTS software implementation and new software development. Will assess to extent COTS can meet requirements.	Scope involves development of comprehensive statewide transit trip planning system covering over 200 public transportation providers across state. Breadth is initially focused on transit trip planning put there are plans for future features such as electronic fare payment and wireless/PDA support. Multi-phase implementation.	System must interface to many existing transit systems. Plans underway to integrate Oregon system with similar transit trip planning system developed separately by Washington DOT.	Technology evolution an important issue as there are a number of systems to be interfaced that will involve changing / advancing technology. Determing how to design for initial application while keeping mind future anticipated functionality is important.	Complex project likely involving new software development will require early emphasis on developing requirements and a formal requirements management process throughout the development effort.	Significant institutional hurdles to overcome considering number of existing transit service providers and desire to integrate with adjacent state DOT effort to be developed under separate contract.	HIGH	
Install EZ-Pass ETC system on New Jersey Turnpike	Category 3	ETC	Complex	Implementation of previously existing and proven ETC hardware. Some development required to account for variable distance-based toll.	Application of proven well known hardware based on existing EZ-Pass installations throughout North East. Geographic scope considerable as initial plance called for equipping 344 toll lanes with ETC technology. Multi-phase implementation.	Interface to existing EZ-Pass centralized financial clearinghouse well known.	At time of implementation, technology evolution not a large issue as specifications for existing reader equipment and toll tags based on existing systems and need to be compatible.	Hardware and related field installation requirements well known. Back-end processing software requirements less know as system had to be designed to account for distance based tolls.	Significant - becoming part of EZ-Pass Inter-agency Group (IAG) and becoming part of EZ-Pass Business model issues that were overcome	HIGH	Could be future technology evolution issues based evolving 5.9 GHz DSRC standards.
Implement AVL and automated scheduling, disptaching, and billing software covering three transit systems in three counties in north Florida	Category 3	RTranM	Complex	Implementation of COTS based software and hardware from multiple vendors.	Implementation of COTS GIS-based routing software, cellular-based AVL system and COTS based AVL software and mobile computing hardware from another vendor. Multi-phase implementation.	No interfaces between existing systems; rather interfacing accomplished through purchase and deployment of same GIS-based routing software.	Technology evolution not considered major issue during implementation, but could become issue in future as agencies look to expand capabilities and functionality.	Use of COTS software and hardware, however, effort required more time spent developing operational requirements for all involved operating agencies.	Significant - coordination of deployment among four rural tranist agencies a signifcant issue. Lack of staff / expertise issue during system installation.	HIGH	

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Develop map-based ATMS control software for LA TMC and install as state standard in 12 other rural and urban TMCs in California	Category 3	FMS	Complex	Implemention of developed TMC software in state TMC's as standard operating system.	Involves implementation of developed softare and recommend standard COTS hardware. Software functionality is for control of all ITS field devices and will allow distributed access to devices among state TMCs. Software functionality deployed in phases.	State TMC interfaces through deployment and use of compatible standard central software.	Technology evolution of field devices and state based standard software functionality a signficant issue.	Development of software used as state standard requires formal requirements management process.	Internal coordination amongst all involved districts a signficant instituional issue.	HIGH	
Install PrePass system at 20 weigh stations and electronic one stop shopping system in Illinois	Category 3	CVO/CVISN	Complex	Implementation of existing, proven COTS software and hardware.	Implementation of proven well known hardware based on existing roadside applications. Techologies include transponders, readers, and WIM. Site deployment involved multiple phases.	Interface to existing state safety and registration databases required to verify compliance.	System hardware and software based on COTS. Equipment specs defined based on need to be compatible with over 240 operational sites across the U.S. Possible future issue with advent of DSRC standards.	Hardware and related field installation requirements well known. Attention to specific requirements for interface to state systems requires attention to some level of requirements definition and management.	Issue of who gets to by-pass. Only carriers with proven safety records can particpate.	MODERATE-HIGH	
Construct and activate Statewide Operations Center in KY including Public Safety dispatching and back-up EOC functionality	Category 4	FMS/PS/EM	Very Complex	Implementation of a combination of existing and new central software along with new COTS hardware.	Involves construction of new facility, integration of new hardware and software. Functions include traveler info, DMS, CCTV control, RWIS, and centralized dispatch for all KY vehicle enforcement uniformed officers. Multi-phase implementation.	Includes interfaces to existing systems such as RWIS and the Condition Acquisition Reporting System (CARS), public safety disptach system, and plans for state-owned signal systems.	Technology evolution a major issue as field hardware and existing system software will have impact on central system software.	Size and complexity of projects requires formal requirements management process.	Major - Institutional issues related to forming partnership with public safety to include dispatch operations in TOC.	VERY HIGH	

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Deploy region wide SmarTrip fare payment system in metropolitan Washington, D.C.	Category 4	EFPS	Very Complex	Involves upgrade of existing system software to include a newer generation fare collection system.	In addition to upgrade of existing system software, involves development and implementation of central database to collect transaction data from 16 partner agencies and point-of-sale network. O&M also included for customer service, card management, transaction clearing and settlement, etc. of Regional Customer Service Center (RCSC). Multi-phase implementation.	Doesn't include interfaces to other agency systems, but does include establishing POS network with compatible equipment and separate purchase and installation of compatible fare collection equipment by regional partner agencies.	Technology evolution a major issue to contend with. For POS equipment, a proprietary card-to-reader interface is necessary to operate with the legacy SmarTrip system, but system is upgradable to International Standards Organization (ISO) compliant card.	Complexity of establishing RCSC and associated POS network requires a formal requirements management process.	Major institutional issues in having to coordinate compatible system deployment among 16 regional transit agencies.	VERY HIGH	
Develop new control software including integration of legacy and planned ITS field equipment for the MTA B&T ATM IDEAS system in NY	Category 4	FMS	Very Complex	Advanced Traffic Management Incident Detect / Evaluate / Act System (ATM IDEAS) involves new development, COTS software and hardware, and legacy software integration.	Includes construction, communications, software development and deployment, legacy system expansion, ITS field equipment deployment, AVL/GPS, ETC, operations and maintenance. Multi-phase implementation.	Includes interfaces to several legacy systems such as analog CCTV camera system, HAR, radio system. External interfaces include TRANSCOM and E-Zpass.	Technology evolution a major issue to contend with. Standards being used to extent possible such as DMS NTCIP center-to-field standards.	Complexity of implementing ATM IDEAS requires a formal requirements management process.	Major institutional issues in having to coordinate ATM IDEAS internfally (linking together eleven small operations centers together with a new Centeral Operations and Control Center. Also externally with numerous operating agencies/entities in region.	VERY HIGH	

Appendix - Example ITS Projects

ITS Project Description	Category	System Type	Complexity	Level of New Development	Scope & Breadth of Technologies	Interfaces to Other Systems	Technology Evolution	Requirements Fluidity	Institutional Issues	Overall Risk	Remarks
Capital Wireless Integrated Network (CapWIN) Project	Category 4	PS/FMS	Very Complex	CapWIN involves new software development and implementation of COTS software and hardware.	Includes development of secure web-based software for mobile field users and center users. Includes implementation of network operations center housing all gateway and messaging switching hardware. Software functionality delivered in phases.	Includes interfaces to existing law enforcment databases and transportation systems.	Technology evolution a major issue to contend with. Private wireless services used by CapWIN users continues to evolve impacting speed of software client functions. Justice and transportation standards development efforts impact design of external agency interfaces.	Project complexity, new software development, and evolving requirements necessitates formal requirements management process.	Major instutional issues in coordinatiig a system linking senstive law enforcement databases, and 40+ public safety and transportation agencies in Metro DC region.	VERY HIGH	

[1]Aurora is an international program of collaborative research, development, and deployment in the field of RWIS involving U.S., Canadian, and European agencies.

FMS = Freeway Management System
TMS = Transit Management System
ETC = Electronic Toll Collection
TIS = Traveler Information System
IMS = Incident Management System
AMS = Arterial Management System
O&M = Operations & Maintenance
EFPS = Electronic Fare Payment System
PS/EM = Public Safety / Emergency Management System
CVO/CVISN = Commercial Vehcile Operations / Commercial Vehicle Information Network
WS = Weather System
RTM = Rural Traffic Management
RTIS = Rural Traveler Information
RTranM = Rural Transit Mobility

APPENDIX G

TASK 4 WORKING PAPER

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The Impact of the Selected Procurement Approach to the Systems Engineering Process

BACKGROUND

The successful procurement of Intelligent Transportation Systems (ITS) is a challenging task for state and local agencies. The procurement process must be flexible to accommodate the uncertainties of complex system acquisitions, while at the same time rigid enough to ensure that the responsibilities of the participants are fully defined and their interests protected. This process should also ensure that the most qualified organizations are selected for the system implementation.

The Transportation Research Board (TRB) through the National Cooperative Highway Research Program (NCHRP) has initiated the development of a Guide to Contracting ITS Projects (Project 3-77). This guide will highlight best practices and recommend contracting strategies and contract types, terms and conditions for the planning, design, implementation, integration, system acceptance, warranty, maintenance, and upgrade of ITS.

The activities outlined in the scope of work for this project are:

- Task 1 – Review of Transportation and Technology Literature
- Task 2 – Look at Other Industries
- Task 3 – Categorize ITS Projects
- Task 4 – Systems Engineering Process
- Task 5 – Recommend Contract Types
- Task 6 – Prepare a detailed Outline of the Guide
- Task 7 – Prepare the Guide
- Task 8 – Submit Final Report

The application of systems engineering principles to the acquisition of an intelligent transportation system will significantly increase the likelihood of a successful implementation. The contracting processes employed, to a large degree, determine the manner in which these principles are applied as well as the assignment of responsibilities for their application. These processes will all also influence the procuring agency's ability to ensure that contractors with appropriate systems engineering skills are employed to lead the project development. In many respects the contracting processes used can have as much of an impact on the project's success as the statement-of-work and system specifications.

When performing this work, it was concluded that some of the principles of project management, unique to ITS acquisitions should also be considered. For this reason, the aspects of project management that are influenced by the procurement process have also been included in this report.

The purpose of this task 4 working paper is to provide a description of both the systems engineering and contracting concepts and an overview of relevant project management principles. This information is then followed by a description of the relationships and interactions among the three. It must be emphasized that this working paper focuses on fundamental relationships. It is not intended to address the actual contracting guidelines (i.e. what is the best contracting methodology for a particular system and agency), which are the subject of the activities of Task 5.

This working paper describes and analyzes alternative contracting procedures currently used by the ITS community. It does not suggest new (and untested) possibilities. A discussion of these alternatives is provided in subsequent tasks. However, the report is significant, in that it serves as a primer for the subjects of contracting and systems engineering, and because it suggests new ways of looking at the relationship between these disciplines.

OVERVIEW OF THE SYSTEMS ENGINEERING PROCESS

This overview of the systems engineering process emphasizes its application to the acquisition (procurement, planning, design and implementation) of intelligent transportation systems. This discussion does not provide an extensive discourse on the subject systems engineering, but instead, describes process at a level of detail that will ensure an understanding of its relationship with procurement alternatives.

The principles of project management are also summarized here because of their impact on the manner in which systems engineering is conducted. Here again, the description of the project management process is intended to highlight the unique requirements of an ITS project, rather than to serve as a textbook on the extensive subject of project management.

ITS PROJECTS ARE UNIQUE

When compared with traditional civil sector infrastructure projects such as highway or bridge construction, ITS projects have some unique aspects that must be considered, including:

- Real-time information technology (IT), which, during the acquisition process can present many challenges because of the difficulty of:
  - Developing accurate estimates of system development costs and schedules (One reference indicates that during the initial planning stages of an ITS project, cost and schedule estimates are accurate within +/- 400%)[1]

[1] Kemerer, C.F., "Software Project Management Readings and Cases", Pg. 63, Irwin/McGraw-Hill, New York, 1997

  - Fully defining and specifying system characteristics
  - Controlling changes in project (and system) scope. Changes in scope typically occur at an unacceptable rate of 1% to 2% per month.[2] Appropriate application of systems engineering practices have been found to reduce scope changes to less than 5% over the life of a typical project.[3]
  - The management of information systems personnel can be difficult. Because of the creative nature of this profession, the implementation of formalized development processes and production of comprehensive documentation can be challenging. In addition, information systems staffs are often characterized by high turnover rates that threaten the continuity of long-term project developments.
- The need to include numerous stakeholders during the definition of system requirements, and during the system development. This results from the broad range of disciplines and organizations affected by most ITS developments. For example, a typical traffic management system may require the involvement of system operators, maintenance personnel, police, transportation engineers, planners and managers.
- Absence of starting and end points. This is the result of the introduction of relevant new technology at a pace that is shorter than the system development time. There is a continuing need to upgrade or replace computers, communications equipment and third party software.
- Interaction with many different types of equipment. Intelligent transportation systems are unusually complex (even when compared with more conventional information technology-based systems), in that they often control a variety of field devices, large screen displays, remote terminals, computer peripheral equipment, telecommunications equipment, etc. furnished by many different suppliers.

Systems Engineering Basics

A system is a set of components (hardware, software, processes and people) that work together to achieve a common objective. Systems are made up of subsystems, which are groups of components within a system that work together to perform specific function. For example, if an automobile is considered a system, the springs and shock absorbers are considered to be the suspension subsystem. Similarly, in a transit management system, the radio, vehicle location equipment, data entry equipment, and driver displays are considered to be components of the vehicle subsystem of the overall transit management system.

[2] McConnell, S.C., "Rapid Development: Taming Wild Software Projects", 1996.
[3] Dennis A., et al, "Systems Analysis and Design: An Object-Oriented Approach with UML", Pg. 83, John Wiley and Sons, Inc., 2002.

Systems engineering is a defined process that uses managerial and technical tools to analyze problems and provide structure to the overall process of planning, procuring, designing, implementing and testing a system. Systems engineering is the process by which we build quality into complex systems; it focuses on ensuring that requirements are defined early in the process and that the system satisfies these requirements. It also ensures that systems are not only robust but also incorporate the flexibility needed to satisfy needs that evolve during the system's life. Systems engineering supports the management of project activities, including monitoring and estimation of cost and schedule constraints, controlling project scope, managing risk and tracking development progress.

A system life cycle begins when the need for the system is conceived and ends when the system is discarded. The system life cycle is typically described in terms of the following stages:

- **Conception:** This stage begins when the need for a system is recognized. Two activities are required in this phase, 1) perform a needs analysis, and 2) develop a concept of operations. For example, if a transit information system is being developed, the concept of operations might indicate that "bus location information is needed to inform passengers of estimated times until the next arrival of a bus can be expected". Thus the concept of operations is not describing the system requirements or its design. The concept of operations describes how the system is embedded in the business processes of its users.
- **Requirements:** This stage defines what the system must do. Using the example of the transit information system, one requirement might indicate that the "system shall provide bus arrival information at all bus stops".
- **Design:** This stage defines how each requirement of the system is satisfied. Using the example of the transit information system, the design specification might indicate that: "variable message signs shall be installed at all bus stops". This high level design specification will be supported by a series of more detailed, lower level specifications such as: "The variable message signs shall be capable of displaying four lines of text."
- **Implementation:** This stage transforms the design into an actual system. This is the stage at which the variable message signs in the design example are installed.
- **Integration and testing:** The testing stage overlaps implementation. It begins with the testing of units of equipment (or software modules). Individual modules are integrated into subsystems, which are also tested. Finally, the subsystems are assembled into an overall system. The entire system is then tested by the developer and then at the customer's site using an acceptance test process. This is the stage at which the fact that the signs are capable of displaying four lines of text is confirmed.
- **Operation and maintenance:** This is the longest stage, during which, the system is operated and maintained during its useful life. The maintenance process

ensures that the system performs satisfactorily and includes system upgrades and expansion.

THE "V" MODEL OF SYSTEMS ENGINEERING

A model has been developed by the systems engineering community that serves as the framework for defining a system life cycle. A system life cycle begins when the need for the system is conceived and ends when the system is discarded. The model includes a basic "V" shape along with wings to the left and right that are intended to represent a definition of the context within which the system is being developed, and the process for changes and upgrades respectively. The overall model is shown in Figure 1.

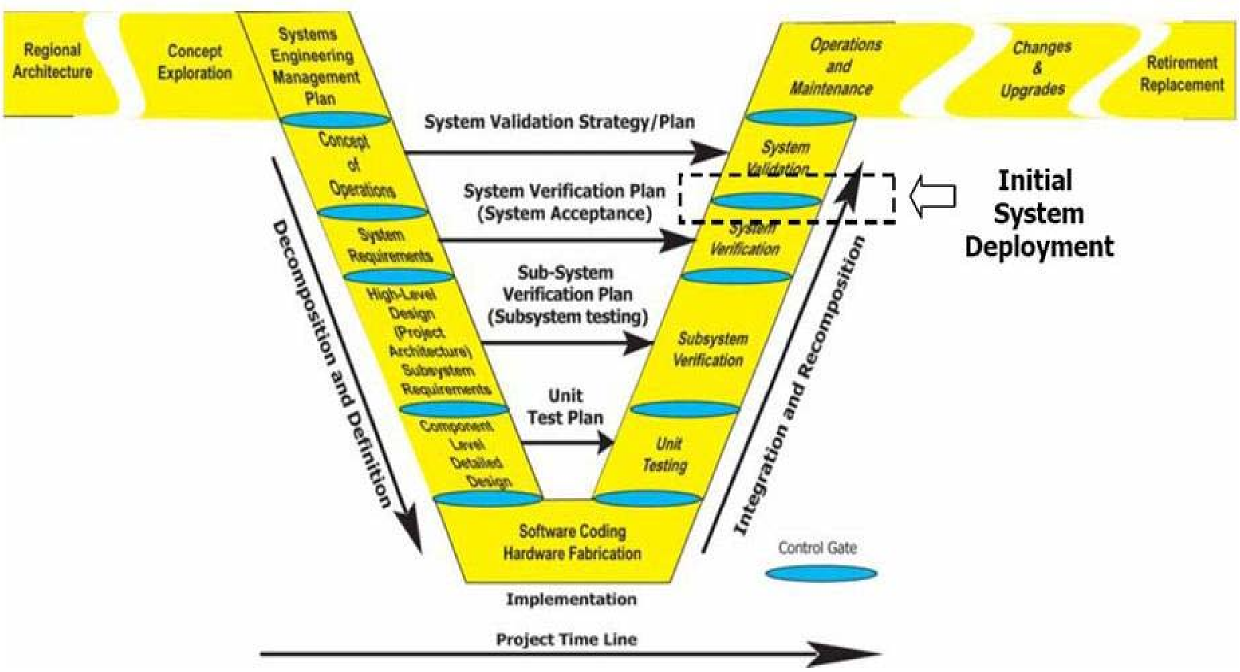

Figure 1. The "V" Lifecycle Model of Systems

The left wing of the system lifecycle model represents the initial planning for the system. It defines the manner in which it fits into the technical and institutional context of the region, and is defined during the creation of the regional ITS Architecture. The key activities of this phase of the system life cycle are the identification of the regional stakeholders and establishing a consensus for the purpose of information sharing and long term operations and maintenance. Also included in the left wing of the model are the activities associated with establishing the feasibility of the project including a benefits analysis that defines the problem, the metrics by which the solution to the problem will be evaluated, establishes goals, and defines the benefit/cost analysis that will be used to justify the system and judge its success.

The development of a specific system begins with the preparation of a systems engineering management plan and continues through the planning (represented by the concept of operations and shown on the left side of the "V"), through the system deployment and validation activities shown on the right side of the "V". The arrows on the outside of the "V" in 1 show the time sequence of these activities. In other words, the activities shown in the "V" also represent a progression in time when moving from the left side of the diagram to the right.

The systems engineering management plan includes a set of master plans and schedules that identifies the needed technical and project management information for the implementation of the project. These plans, along with the concept of operations become the control documents for the project implementation.

The right wing of the "V" includes the ongoing activities that occur following the acceptance of the completed system. These activities include operations and maintenance, the inevitable changes and upgrades associated with all high technology systems, and the ultimate retirement and/or replacement of the system. These activities are critically important, and must be subjected to the same systems engineering processes that were used during the system development. Plans must be developed for the system validation, as well as the operations and maintenance that define the metrics that will be used to determine the success or failure of these activities. Maintenance activities must include change control (including configuration management) contracting plans, and risk analysis. Contracting plans must be developed that define the resources that will be required to support these activities, and the staff and financial resources required for their successful execution.

The "V" shape is used for the central part of the diagram to indicate the relationship between the planning, requirements and design activities on the left side of the "V", and the testing and validation activities on the right side of the "V". These relationships are indicated by the horizontal arrows in the diagram. Verification includes several sets of system testing beginning at the lowest level of unit testing, and proceeding to the highest level of verification identified as system verification testing (also known as acceptance testing). These tests are conducted to determine whether the "system was built right". The validation process, which is also shown as a horizontal line in Figure 1, is used to determine whether the system satisfies the needs of the organization and its stakeholders as defined by the Concept of Operations. In other words, validation is used to determine whether the "right system was built". As noted below, validation can also be considered an element of the right wing of the system, since it is performed on an on-going basis once the system is operational. These specific verification and validation relationships include:

- **Concept of operations vs. Operations and maintenance:** The concept of operations describes how the system will interact with the agency's business practices once it has been fully developed and accepted. This relates directly to the operations and maintenance stage, at which point the system is being used operationally as an integral tool of the business practices. A knowledge and awareness of this relationship ensures that focus is place on issues that will keep the system operating and effectively maintained once it's built. This level is considered system validation since it confirms that the system that was developed to solve a specific set of operational needs, does in fact meet these needs. In other words, "Was the right system built?"

- **Requirements analysis vs. System verification:** The requirements analysis defines the functions the system must perform. It also defines the precision with which they must be performed as well as the system speed, capacity, etc. The overall system verification (acceptance testing) determines whether the system satisfies the system requirements. The latter involves the verification and validation of the system that can be phrased as a counterpoint to the question asked in the concept of operations. In other words this level of testing determines whether "the system was built right".
- **High-level system design vs. Integration and testing:** High-level design breaks down the overall system into subsystems, each of which is assigned to a major functional area of the system. The subsystem verification integrates and tests the subsystems as units. So, there is a clear correlation between these two stages.
- **Detailed design:** This step relates to the definition of the complete system at the greatest level of detail. It also includes the specification of individual items (lines of code, software modules, hardware units) and their associated subsystems. Much of the work performed at this stage may be invisible to the agency, since it is performed at a level of detail required by the system implementers. The agency must only be concerned ensuring that the high level design and requirements meet its needs. It is the contractor's responsibility to ensure that the detailed design reflects the high-level design specifications.
- **Implementation:** This stage transforms the design into a fully operational system.
- **Operations and Maintenance:** The final step of the "V" is the operations and maintenance, which occurs following the system implementation. It is essential that planning for operations and maintenance occur during the initial stages of the development process (concept of operations). One of the primary purposes of the concept of operations is the definition of responsibilities for operations and maintenance including identification of the possible need for outsourcing operations and maintenance services. The issues to be considered when planning for operations and maintenance include:
  - The need for outsourcing – are the resources and skills required for operations and maintenance available from agency staff, or will it be necessary to outsource these services?
  - What quality of O&M is required in terms of response times, system availability, hours of operation, etc?
  - What are the requirements and availability of funding for O&M?
  - Will maintenance requirements be specialized such that the installation contractor must play a role in providing these services?

- If a phased development is being pursued, will maintenance be considered an integral part of each development phase?
- What guarantees and warrantees can be anticipated from the installation contractor and its suppliers? How will this affect the maintenance costs?
- Will intellectual property rights affect the ability to employ a third party for system maintenance, or will the system documentation be furnished in adequate detail to permit the acquisition of maintenance services from other than the system implementer.

The resolution of these issues is very important, since it will influence the budget and contracting requirements during the systems engineering process.

- **System upgrades:** As anyone who has ever owned a PC knows, there will be a continuing requirement for system upgrades throughout the life of the system. System upgrades are part of the operations and maintenance process. There will be a continuing need for upgrades as new releases of operating system and other third party software become available. There will also be a need for hardware upgrades due to aging of equipment, changes in technology and incompatibility of older equipment as other parts of the system are being replaced. The process of system upgrades is considered a part of the operations and maintenance process.

In addition to its use in defining the relationship between processes for the purpose of defining validation and verification activities, the “V” shape also represents the level of detail at which the system is being analyzed. The upper-most activities on each side of the “V” (concept of operations and Operations and Maintenance) define the system at its highest level. They must consider both the total system and its user interactions. The processes at lower levels of the “V” describe and work with the system with increasing detail, until one arrives at the bottom level (implementation) at which point the system is being considered at its most detailed level. At this level, the systems engineering process is involved with the definition, implementation and testing of individual lines of computer code, wires and components. The steps on the left side of the “V” (Concept of Operations to Implementation) are considered to represent the process of “decomposition”. The steps taken when proceeding up the right side of the “V” are known as “recomposition. In other words, the left side of the “V” decomposes the system into its most basic elements, while the right side of the “V” reconstitutes these basic elements into a complete operational system. The steps that are horizontally aligned in the “V” (such as the requirements and system verification) are intended to represent the same levels of decomposition/recomposition. Because of these horizontal relationships, the tests (also known as verification) that must be conducted while the system is being “recomposed” are defined by their associated planning/requirements/design activities.

SYSTEM DEVELOPMENT PROCESS MODELS

Systems engineering process models define alternative applications of the “V” diagram to the systems engineering process. A well-developed model also supports the project management process in that it defines the system acquisition steps, and helps convey to the team and others how a project will be managed. The process model also determines the procurement approach being used for the system acquisition. The process model must define the procurement approach rather than permitting the procurement approach to define the systems engineering process. In addition, the model helps communicate with others about the progress being made, it helps assess the risk of alternate paths, and it helps to take advantage of emerging opportunities. Alternative system development processes include:

- Waterfall Model
- Evolutionary Model
- Spiral Model

The selection of this process is a significant part of the project, as it determines the scheduling, contracting and many other project activities. No single model is applicable to all types of projects. The challenge is to select the most appropriate model for the implementation of a given intelligent transportation system.

Waterfall Model: Until recently, the waterfall model was one of the more commonly used models used for the system development process. As shown in figure 2, this model defines a linear process in which the steps of planning, designing and implementing (and their further subdivisions) are performed sequentially. This method of analysis was the dominant approach to system engineering during the 1980's, and is representative of the highway design and construction process. The waterfall model was designated the waterfall process because the series of steps shown in figure 2 are typically drawn in a descending pattern reminiscent of a waterfall. In actuality, the steps shown in figure 2 are no more than the representation of a single pass through the steps of the "V" diagram of figure 1.

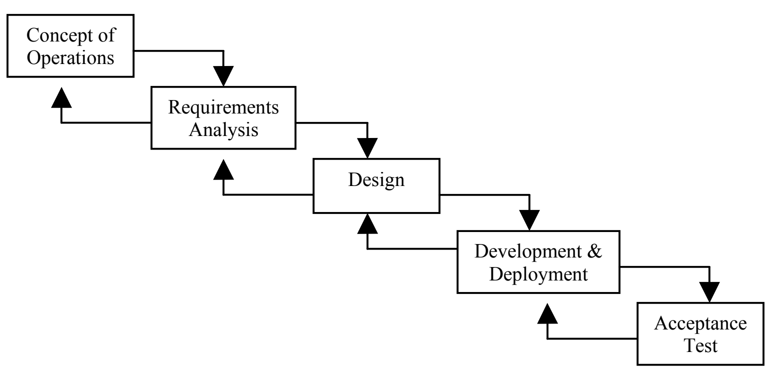

Fig. 2 Water Fall Model of Systems Life Cycle

The waterfall model defines the execution of the steps of the system development, and provides a limited capability to modify the previous step based on the activities of the current step. The arrows facing to the left in the diagram represent the fact that activities occurring during one step will cause the review and modification of a previous step. Suppose, for instance, that while acceptance tests are being conducted, it was concluded that an operator display was awkward to use. This recognition requires a system software modification. If the software modification is documented and managed correctly, it should be preceded by a modification to the system design. The system design, in turn requires a modification of the requirements. Thus, in effect, the developer is traveling up the waterfall (swimming upstream). Rarely are documentation changes correctly controlled to reflect changes made late in the system life cycle. Failure to make these changes frequently leads to maintenance problems during the operations and maintenance stage of the life cycle.

In spite of the possibility of managing changes by traveling up and down the waterfall, this model is, in actuality, representative of a straightforward linear process. Because of the difficulty of swimming upstream with the waterfall model, it is appropriate for simple, well-defined systems, with functions and features that are proven and have been implemented elsewhere (such as Category 1 and 2 projects defined in Task 3) to minimize the number of times that the upstream direction must be traversed. If there is uncertainty regarding the final functional capabilities of the system (which is characteristic of systems that must satisfy the needs of multiple stakeholders), other process models should be used.

Spiral Model: The spiral model is intended for the acquisition of systems involving the development of new applications. For example, this model might have been used during the development of control centers for the automated highway system. It is characterized by a repetitive process of planning, requirements, design and prototyping. Prototypes are then evaluated to determine the degree to which they satisfy the initial vision and concepts of operation.

As shown in figure 3, the spiral model begins with the definition of a vision for the system. Once a vision has been defined, a risk analysis is generally performed that identifies some of the higher level risks associated with the implementation of the vision. A prototype is then used to support the development of a concept of operations, to provide an initial visual representation of the system operation that can be used to support the planning process. As with the waterfall model, the concept of operations is then used to define requirements, and produce a design. Additional prototyping is performed throughout the process utilizing the results of the requirements and design. Although not explicitly shown in the diagram, the requirements may also be supported by a prototype development, which may be used as a visual representation of the requirements. Risk analysis is performed frequently throughout the process.

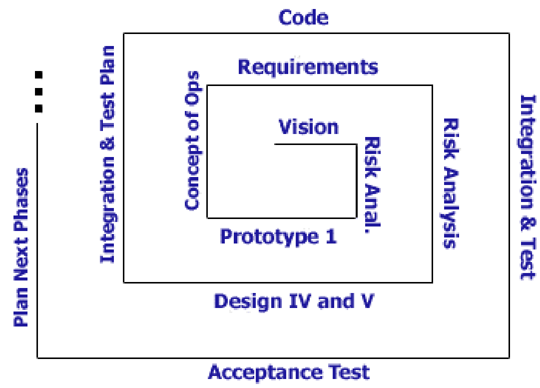

Fig. 3 Spiral Model of Systems Life Cycle

The spiral model is not a well-defined system engineering process. These steps may be performed in any order, depending on the application being examined. The spiral representation is used to define an expanding level of detail and understanding of the application as it is developed through the use of multiple prototypes and designs. The iterative nature of the spiral model permits the prototyping process to be repeated as many times as necessary. When the designers (and customers) are confident that the prototypes meet their needs, final design and implementation is initiated.

The spiral model is applicable to the development of new systems and applications that are not well defined, and circumstances under which the agency wants to examine many alternative designs – which may include particular emphasis on input and output formats (such as Category 4 projects defined in Task 3). The use of the spiral model can be an expensive process and for this reason, it should be used only by organizations that are “breaking new ground”. For example, in the ITS community, this approach should be considered for some of the newer emergency preparedness applications being considered for the surface transportation system.

Evolutionary Model: The Evolutionary Model is a formalized description of a phased system development. As its name implies, the evolutionary model defines a sequence of stages such that the system evolves through a sequence of versions, such that each version is closer to its final vision.

The evolutionary model can be described graphically as a linear sequence of "Vs" connected end-to-end. The use of the “V” to describe an evolutionary phase is intended to indicate that all the activities included this diagram, up to and including operations and maintenance are executed for each development. See figure 4. This version of the evolutionary development may also be called sequential or iterative development. It begins with an initial vision, which defines the final goal of the system, as well as the functions to be included in each of the phases. It is recommended that the duration of these phases be from nine months to one year.

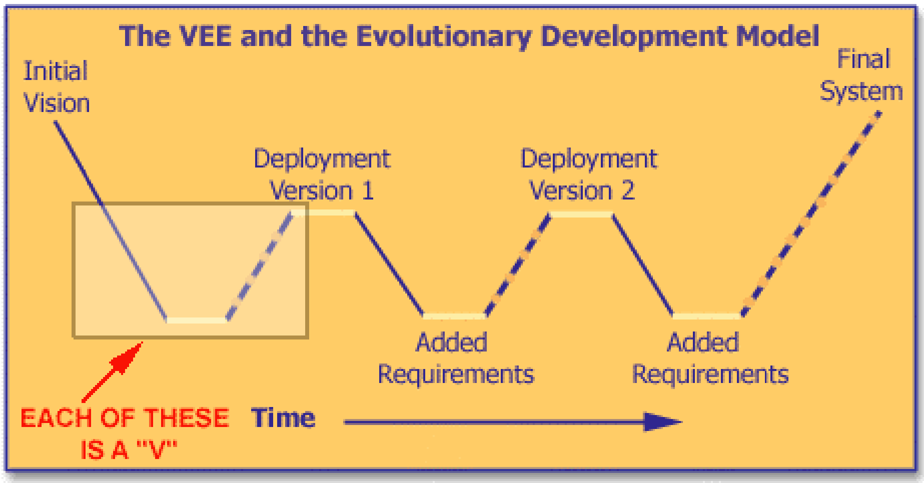

Fig. 4 Evolutionary Model of Systems Life Cycle

The evolutionary model recognizes the difficulty of fully and accurately defining the total set of requirements and specifications for software-based systems. It also recognizes the inaccuracies of estimating the cost and schedule of these systems, which as previously indicated can be subject to errors of +/-400%. Finally, it recognizes the possibility of project scope changes at a rate of 1% to 2% per month. By dividing the project into smaller "bite-sized" pieces, the impact of these inaccuracies and scope changes are minimized. A one-year project phase is likely to experience manageable changes in scope of 12% to 24%. If the entire project were developed over a longer period (of say 5 years), it would experience scope changes in the range of 48% to 96%. Thus, a five-year project that has not been divided into shorter phases might never be completed, since at the end of the five-year period an entirely new set of project requirements will have been defined. This phenomenon has been experienced all too often in past ITS projects. With the evolutionary model, further control over scope changes can be exercised by deferring desired changes for later project phases. Finally, lessons learned during the development of one phase can be incorporated into subsequent phases.

It is not necessary to develop each phase in an entirely sequential manner. The planning and requirements steps of one phase can be initiated while final development and testing of its predecessor is underway. However, it is important not to begin the planning and design of the subsequent phase too early, since if this occurs, it will not be possible benefit from the lessons learned during earlier developments.

The evolutionary model is applicable to systems that require multi-year development, with functions that can be logically separated. For example a freeway management system might include the variable message sign control in one phase, detector data processing in a second phase and elaborate graphical displays of traffic and incident information in a third phase. It might also be possible to include limited field deployment of two or three variable message signs during the first phase, and further expansion of field equipment during subsequent phases.

Thus, the evolutionary model is very applicable to ITS systems, which can typically be functionally and geographically decomposed. It permits control over requirement changes, since new requirements can be delayed for subsequent iterations. It also allows the agency to familiarize itself with the system, because they can use the system that was developed during one "V" phase while a second iteration is underway. This model is a tested approach to the development of ITS systems, having been used on several successful system developments throughout the United States. It should be applied to systems that include any of the following characteristics (consistent with Category 2 and 3 as defined in Task 3}:

- Moderately Complex to Complex
- System requirements not completely defined
- Involve the development of new software or new functions for existing software
- Need to account for technology evolution over the system life cycle
- The first system of its type developed by the procuring agency

CROSS-CUTTING SYSTEMS ENGINEERING ACTIVITIES

A number of activities are conducted continuously during the system acquisition process. These activities are designated cross-cutting, in that they are performed during all of the systems engineering steps of planning, requirements, design, implementation and testing. These four activities, which include configuration management, risk management, validation and verification, and metrics, serve as the supporting framework for the system development. They are summarized here. Many systems engineering references and courses exist that define these activities in greater detail.[4]

Configuration Management: Configuration management is a "process for establishing and maintaining consistency of a product's performance, functional and physical attributes with its requirements, design, and operational information throughout its life. It is a process, which ensures that the system performs as intended and is documented to a level of detail sufficient to meet needs for operation, maintenance, repair and replacement. " [5] Implicit in this description is the fact that configuration management applies to the entire system life cycle beginning with its planning and continuing through operations and maintenance. Configuration management also ensures consistency between requirements, design and operation. During system implementation, every hardware unit and every software module must have a supporting set of specifications, and it must be possible to associate each specification with a requirement. Similarly, it must be possible to identify a set of specifications that define every hardware and software module being acquired or programmed. There must also be an acceptance test for each of the requirements. The relationship between requirements, specifications, hardware and software modules, and tests is maintained in a database known as a traceability matrix, which is used to define their associations. This often-overlooked

[4] Sage, A.P. and Armstrong, J.E., "Introduction to Systems Engineering", Wiley and Sons, 2000.
[5] ANSI/EIA 649 1998, National Consensus for Configuration Management 8-55

aspect of system implementation is an essential element of the systems engineering process.

The Configuration Control Board (CCB) is another important element of configuration management. All of the key participants in the system development must be represented on the CCB. Typically, they include the agency's project manager, the contractor's project manager, systems engineering personnel, configuration management personnel, a manager with the authority to commit funding to the project, and other stakeholder representatives and specialists as required by the subjects being discussed. All changes to the system including new requirements, design changes, value engineering changes, bug fixes etc. must be approved by the CCB before they are implemented. Implementation can only be initiated following the incorporation of suitable changes in the requirements and other project documentation. Change requests submitted to the CCB must be based on a formal process that includes the justification for the change, its anticipated cost and schedule impacts. If practical, the CCB will often defer non-critical changes to subsequent project phases. The CCB's role is to ensure that configuration management procedures are implemented and to control the rate of scope creep that the project experiences. It requires close interaction between the agency and the contractor for its successful implementation. Practice has shown that the CCB can significantly reduce the rate of scope creep experienced by a complex project.

Risk Management: Risk management is the process of identifying potential problems before they occur, planning for their occurrence and monitoring the system development so that early actions can be taken. A typical ITS project potentially experiences many risks from technology, people and management. Representative risks include inadequate products, insufficient funding, staff turnover, delayed deliveries, incorrect schedule and budget estimates, etc. Risk planning cannot be performed in a vacuum. It must be a collaborate process between the contractor and the agency. Each organization has concerns that must be addressed. A plan must be developed for every risk that is identified as important to the success of the project. The plan must include a definition of the risk, its potential impact on the project if it occurs, and the mediation measures that will be taken to alleviate its impact. The plan must also include the metrics (measures) that will be used for early identification of the risk's occurrence.

Validation and Verification: Validation and verification are processes for ensuring that the correct system was built (validation), and that the system was built correctly (verification). Validation occurs at the end of each evolutionary development phase, at which time the system is subjected to actual operational use by its operators and stakeholders. At this time, fundamental design shortcomings (e.g. the system does not adequately serve the organization's business processes) in the system concept may be identified and corrected during subsequent development phases.

Verification is the process of testing the system as it is being developed (unit and subsystem testing). It is also the process of formal acceptance testing of the fully assembled system. Acceptance testing is generally performed at the conclusion of each development phase. Acceptance tests are based on the system requirements using the information contained in the traceability matrix, and must be passed before the agency begins using the system under operational conditions. Acceptance tests must generally be passed prior to final reimbursement of the contractor for work performed on a given development phase.

Metrics: Metrics are measures used to judge the system development progress. Target objectives are generally defined prior to the beginning of development that can be used as the basis for comparison for concluding that development is proceeding in a satisfactory manner. Metrics may also be used as the basis for reimbursing the contractor for partially completed products. Typical metrics might include deliverables (documentation, completed subsystems, installed field equipment, etc.). They might also include comparison of schedule milestones with actual work accomplished. Other metrics include number of requirements defined, number of fully tested software modules, length of communications conduit installed or any other measurement that is an accurate representation of development status. Metrics are tools used to support both systems engineering and project management activities.

PROJECT MANAGEMENT CONSIDERATIONS

It is also important to consider the general principles of project management that must be followed for a successful ITS project. In many respects, these principles are the basis for the steps that have been defined for the systems engineering process, and for this reason, they should be explicitly addressed when selecting the appropriate contracting activity. These principles have evolved from the recognition of the unique characteristics of software-based systems, which include the difficult (if not impossible) task of preparing definitive software specifications, the need to control changes in project scope (scope creep), and the challenging task of developing reliable cost and schedule estimates for the system development. The following principles are key considerations that should be addressed within the project management process:

- **Collaboration** – Historically, the culture of transportation contracting has been based on the contractor's desire to complete the specified work at the lowest cost, while the contracting agency's responsibility is to monitor the contractor's work to ensure that the work is satisfactorily performed. By its nature, this can be a contentious process. A software-based project requires a close working relationship between the agency and the contractor to define the agency's needs and business processes, clarify uncertainties in the specifications, fully define all functions to be performed, modify the work as necessary to meet the needs of the users and stakeholders, etc. In other words, the agency must become a participant in the project rather than an overseer, and the contractor must help define needs rather than attempting to satisfy the requirements of a rigid specification. The need for collaboration exists throughout all project activities, but its presence is most visible in the area of risk management, configuration management, definition of metrics, and preparation of the concept of operations. Without collaboration, it is not possible to ensure the success of a complex system development. Collaboration between the contractor and the agency is an unusual relationship for the highway transportation industry, which is more accustomed to dealing with a low-bid contractor on an adversarial basis. It is difficult but essential to change these ingrained habits.

- **Off-the-shelf-solutions** – The functions performed by ITS systems, are rarely unique. In most cases, they are nearly identical to those of other systems that have been previously installed. For example, the typical freeway management performs a basic set of functions which might include:
    - Variable message sign control
    - Highway advisory radio control
    - Traffic data collection
    - Weather data collection
    - Entry and display of construction information
    - Ramp metering
    - Incident detection
    - Positioning of closed circuit television cameras
    - Display of video images
    - Graphical display of traffic information
    - Logging
    - Storage and display of route diversion plans
    - Control of HOV lanes
    - Control of reversible lanes
    - Maintenance diagnostics

  The relative low number of functions performed in a system of this type, and their commonality with the similar functions of other systems, suggests the use of software developed for previously installed system. This is known as commercial off-the-shelf (COTS) software. The use of COTS software offers a number of advantages over the development of unique software including the acquisition of a relatively mature (previously tested) package, the economic benefits of sharing the cost of upgrades with other agencies and the ability to acquire a package whose capabilities can be viewed prior to the initiation of system acquisition.

  Because of differences in field equipment and other aspects of the system configuration, it is unlikely that the COTS software can be purchased as a "shrink-wrapped" product that can be installed without some modification to reflect the unique conditions of the environment in which it will be used. Whenever possible, functional requirements should be adjusted for compatibility with currently available COTS products, in order to minimize the amount of new software development that might be required.

If many new capabilities and interfaces are required, COTS software cannot necessarily be used. However, even under these conditions, it is desirable to maximize the amount of mature previously tested software and hardware used in the new system. Thus a version of COTS software can be acquired and used in its current form in the new system, or it can serve as the starting point for the system being developed.

If COTS software is a possibility, its use should be considered during the procurement phase of the system acquisition, since the contractor using the preferred COTS solutions should receive priority consideration as the system implementer. Some agencies base their contractor selection on the premise that the companies who do not offer any COTS solutions represent the best (unbiased) choice for system implementation. The selected contractor is then asked to select the most applicable COTS software and manage its installation. Agency's using this approach have frequently encountered difficulties due to the problems of managing two or more organizations (including at least a system designer and a system implementer) with poorly defined responsibilities, who are competitors in the ITS marketplace.

COTS software should always be considered preferable to new software development because it can almost always be acquired at a lower cost, and its use in other locations generally ensures a higher level of reliability than that which would be result from the development of a new software package.

- **Prequalification/certification** – Many projects require offerors (bidders or proposers) to demonstrate that they are qualified to perform work on a planned project before their proposals (or bids) are evaluated. Traditionally, this prequalification activity includes demonstrations of financial capacity to perform the work, or evidence that similar projects have been successfully completed and demonstration of their personnel or other resources availability for the project. In the past, this form of prequalification has proved to be of little value to the development of software-based systems because of the difficulty of defining "similar projects" and "successful completion". As a result, the prequalification frequently leads to protests by firms that have failed to qualify for a project, sometimes with disastrous consequences. A solution to this problem is the use of a prequalification that demonstrates the knowledge and ability of potential bidders to implement the full systems engineering and development process. This demonstration of systems engineering and development capabilities can be established by requiring the contractor's verification that its processes have been verified by an accredited organization. The appropriate certification for software development is known as the Capability Maturity Model (CMM)[6]. CMM defines five levels of proficiency. The chaotic processes of the past are defined as level 1. Levels 2 or 3 are generally adequate for ITS projects. A firm that has received this certification provides the agency with some degree of assurance that the firm has established systems engineering processes, and that these processes are

[6] For more information see: www.sei.cmu.edu/cmm/cmm.html

applied to software-based projects. When requiring CMM certification it is important to ensure that the operational unit performing the work (division, project team, etc.) has been included in the certification prequalification. ITS projects involving the development and delivery of products (such as toll collection systems involving the production of large numbers of toll tags) might consider using the ISO 9001[7] certification in addition to CMM certification. ISO 9000 provides similar verification of the processes in use by potential offerors, but emphasizes equipment development, delivery and installation.

- **Organizational Considerations** – The two elements of an ITS project with the greatest development risk, and the most uncertain costs and schedules are the software and systems integration activities. Yet ironically, the work associated with these elements is usually significantly less than ½ of the total project cost. As a result, a second or third tier subcontractor may perform the most critical aspects of the work, while the prime contractor may be an electrical contractor. This organizational structure places the organization with which the most collaboration is required, at arms length from the agency. Whenever possible during an ITS procurement, organizational structures should be required that permit the agency and the software developer/systems integrator to collaborate on the work, and make necessary adjustments as the work progresses. This can be most readily accomplished if the systems integrator (who is likely to be the software provider) is the prime contractor.

These considerations should be kept in mind when reviewing the contracting alternatives described in the following section.

OVERVIEW OF CONTRACTING

A framework has been developed to support the description and analysis of contracting alternatives analyzed during this research project. As indicated in figure 5, contracting activities have been defined in terms of four dimensions plus the terms and conditions, which are, in effect, a fifth contracting dimension. Terms and conditions are agency-specific and will not be included in this discussion. Each of the dimensions of figure 5 must be analyzed and selected when defining the contracting to be performed for an ITS acquisition. The options and considerations associated with these dimensions are discussed in this section.

[7] For more information, see: http://www.iso.org/iso/en/iso9000-14000/iso9000/iso9000index.html

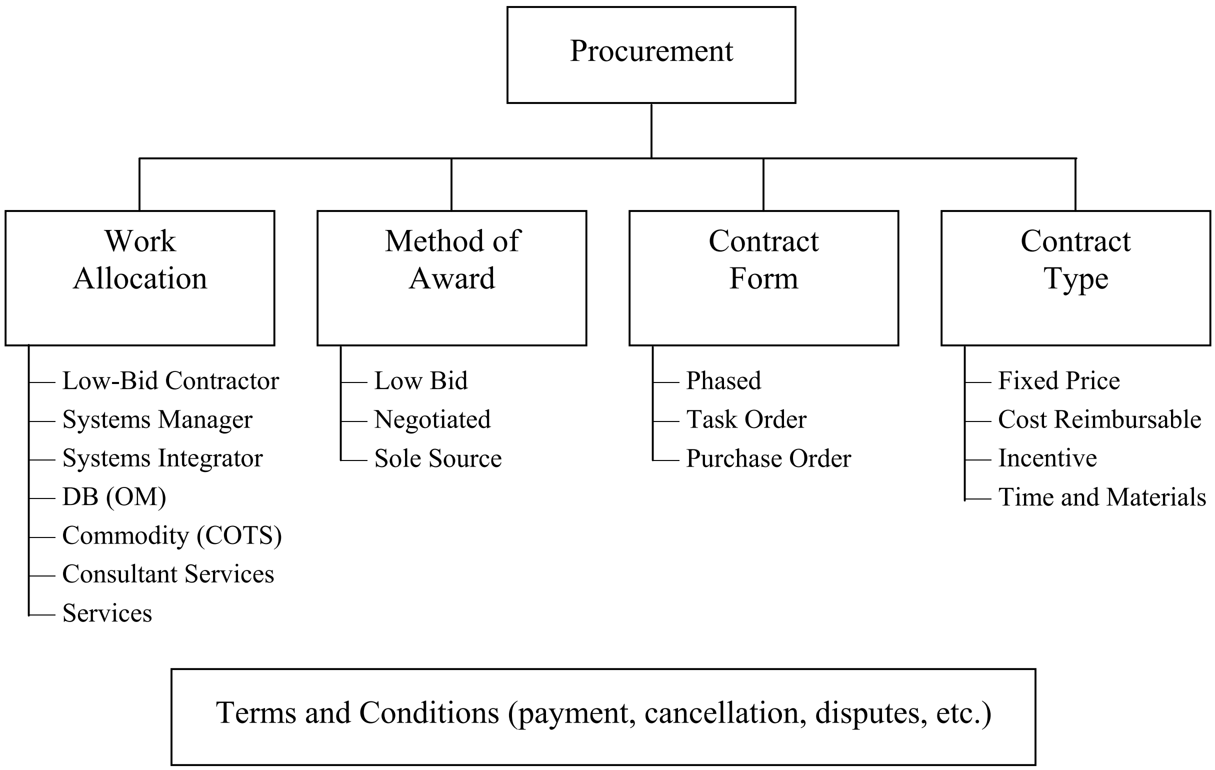

Fig. 5 Contracting Framework

Since contracting terminology is not always consistent, the terms used in the following discussion are defined here. To avoid the possibility of confusion, the following terminology will be used:

- Acquisition – A system acquisition is defined as the entire process of purchasing a system including planning, design, contracting, implementation, testing and acceptance.
- Burden – A percentage charge applied to the direct contract costs that cover the contractor's cost of doing business. Typical burden items include overhead (rent, office supplies, business expenses, office equipment, legal expenses, etc.), fringes (employee benefits - including sick leave, vacation, health insurance, etc.), general and administrative costs (management costs).
- Commodity – A commodity is a product as distinguished from a service
- Consultant – A consultant is a contractor whose work is restricted to the provision of personal services. Consultants are not usually selected on a low-bid basis. They are generally restricted from providing hardware, construction services and electrical contracting services.
- Contract – A written agreement between two parties (in this case it is assumed that the parties will be the agency and an outside organization – usually a private

sector firm) that is an agreement for doing or not doing something that is specified.

- Contracting – The selection of a firm to provide a set of services or products, as well as negotiating and executing a contract.
- Contractor – This term is used in two different ways. The general use of this term is that the contractor is an organization with which a contract has been signed. This general terminology can include a design contractor (consultant), software company, systems integrator, electrical contractor, construction contractor, etc. When the Consultant/Contractor form of work allocation is discussed, the term contractor is a reference to an organization that has been selected (usually on a low-bid basis) to implement a system specified by a consultant. To avoid confusion in the discussion of this form of work allocation, the organization selected in this manner will be referred to as a low-bid contractor.
- Direct Costs – Expenses directly attributable to work performed on a project, as opposed to indirect costs, which are unrelated to specific projects.
- Fee – Synonymous with Profit. The fee (or profit) is the payments received by the contractor in excess of contract costs and burdens that are value-added compensation for performing the work.
- Indirect Costs – Expenses of doing business that cannot be directly attributable to a specific project. Examples of indirect costs include office space, advertising, employee fringe benefits, etc.
- Invitation for bids (IFB) – A document released by a procuring agency requesting bids for services, equipment and/or commodities from potential contractors. A contract is awarded to the lowest responsive bidder.
- Negotiated Procurement – A process by which all procurement terms are discussed and may be reconsidered by the purchaser and the offeror. These terms may include requirements, specifications, period of performance, location of work, scope of services, staffing requirements, etc. Negotiated procurements typically reflect a discussion of non-financial considerations prior to the discussion of the proposed contract cost although this “two step” evaluation is not always required.
- Procurement – Same as contracting
- Request for proposals (RFP) – A document released by a procuring agency asking for the submission of proposals for personal services from interested consultants.
- Statement of Work (SOW) – A section of a contract that defines the responsibilities and work to be performed by the contractor.

Work Allocation

The work allocation category represents the project responsibilities defined by the agency for the contractor in the contract statement of work. These assignments are expressed in the systems engineering terminology – concept of operations, requirements, design, implementation and testing. They also include the crosscutting activities of configuration management, risk management, validation and verification, and metrics.

Low-Bid Contractor: This form of work allocation involves the selection of a contractor for system installation using the low-bid process. The contractor bids on a system design, typically prepared by a consultant. The consultant's responsibilities are included in the "Services" category of work allocation. The consultant may provide a range of additional services including planning (concept of operations), requirements analysis, risk management and inspection. The low-bid contractor is responsible for furnishing a fully operational system including all hardware, software and construction services required to satisfy the consultant's design as defined by the plans and specifications. If required to do so, the low-bid contractor also provides configuration management services. Both the low-bid contractor and the consultant participate in the system verification (acceptance testing). This work allocation typically requires the selection of a design consultant using a negotiated procurement (see definitions), and the selection of a contractor to provide the system using a low-bid procurement.

The allocation of responsibilities between a consultant working in the role of the agency's representative, and a low-bid contractor is the same approach traditionally employed for new highway construction. For this reason, many agencies prefer to use the consultant as a designer and a low-bid contractor to furnish the system. The shortcoming of this approach is that it is difficult, if not impossible, to prepare a set of specifications for a software-based system that fully defines all features and functions to be provided. Low-bid contractors follow <u>their</u> interpretation of the specifications, which might differ from those of the agency. In addition, this approach is not compatible with systems with poorly defined characteristics, because of the likelihood of high levels of scope creep with their attendant change orders. Thus, consultant/low-bid contractor approach is best suited for procurement of very well defined systems that have been installed elsewhere. It should be avoided for any system involving the development of new or modified software.

Systems Manager: The systems manager form of work allocation utilizes an organization known as the systems manager that has been selected using the negotiated method of award.

The scope of work defined by a systems manager contract may include all project activities associated with a system acquisition except for the provision of equipment[8], electrical contracting and construction contracting. In other words, systems managers are operating under the constraints of consultant contracts, in that they can only participate in

[8] There are instances in which equipment can be furnished by the systems manager, subject to the interpretation of the agency's procurement organization. This is the case since the systems manager is only precluded from providing equipment and services that fall under the definition of construction. As a result, many agencies permit the systems manager to furnish control center equipment such as operator workstations, large screen displays and communications routers.

system implementation to the extent that personal services are being provided. Thus the systems manager may provide any combination of the following services:

- Planning and preparation of the concept of operations
- Definition of requirements
- System design including specification of construction services, electrical contracting services and equipment needed for the system implementation
- Software development
- System integration
- Testing at all levels including acceptance testing
- Inspection of construction and electrical contractor's work
- System operation and maintenance
- Risk management
- Configuration management including organization of the configuration control board
- Use of metrics to monitor project progress

The use of the systems manager simplifies the application of the systems engineering process. Thus it is critical that the systems manager be thoroughly versed in the principles and processes of systems engineering, software development and project management.

The agency is responsible for hiring low-bid contractors to provide equipment, construction and electrical contracting services. The agency's responsibility for the acquisition of this equipment and services, places it in an important role that can have a significant impact on the project's success or failure. These services must be acquired in a timely manner, and must be responsive to the requirements of the specifications prepared by the systems manager.

Systems management contracting permits the use of the systems engineering and project management principles that have been discussed. It also permits the use of the evolutionary design process, since systems management contracts can be readily structured to accommodate the development of future system phases. Properly executed, the systems management enhances collaboration between the agency and the organization responsible for the system acquisition. It is significant that, in its role as a systems manager, the organization responsible for the highest risk aspects of the system development is the prime contractor.

Systems Integrator: The role of the systems integrator is similar to that of the systems manager, except that the integrator is not involved in the planning and design stages. The systems integrator provides all of the personal services associated with the systems implementation and relies on the agency to contract for construction, electrical contracting and equipment procurement. This form of work allocation offers the advantage that the systems integrator can be selected using a consultant selection. As the supplier of the software and systems integration services, the consultant becomes a prime contractor with which the agency has direct contact. But it has several disadvantages including the fact that a consultant is still required to perform the system planning and design leading to the problem of multiple points of responsibility as well as the need to coordinate and manage a large number of contractors.

Design-Build (DB) Contracting: DB contracting is based on an agreement "that provides for design and construction of improvements by a (single) contractor or private developer. The term encompasses design-build-maintain, design-build-operate-maintain, design-build operate, design-build-finance and other contracts that include services in addition to design and construction."[9] According to the Federal rule[6], when Federal funds are used in the project, design build contracting may only be used for ITS projects if "the estimated contract value exceeds $5 million". Design-build contracting is permitted for lower cost system developments with the prior approval of the Federal Highway Administration. The rule indicates that a two-step process may be utilized in which a short-list of no more than five offerors is selected based on qualifications, technical approach and past performance. In addition, it indicates that the final contractor selection must include the evaluation of price and the quality of the product or service being offered. Experience and past performance are optional considerations. Anecdotally, many professionals from both the public and private sectors have indicated that many design build awards tend to be made to the lowest bidder.

This form of contracting assigns total project responsibility to a single contractor, rather than splitting the responsibility between a design consultant and a low-bid contractor. The design-build contractor has all of the responsibilities of the systems manager, plus the ability to furnish equipment and electrical and construction contracting services. Design-build contracts are typically preceded by the preparation of a partial design (sometimes designated a 30% design) prepared by a consultant. The design-build contractor is then responsible for completing the design as well as implementing the resulting system. This form of contracting is not allowed by some agencies.

Because they are based on a design planned and partially prepared by others, the design-build approach may experience the same problems as that of the consultant/contractor approach. In fact, the primary difference between the two is that the design-build contractor has the opportunity to influence the design (and subsequent specification) of the system being developed, and the flexibility to offer alternative approaches. However, when the design-build selection emphasizes low cost many of the barriers to collaboration and flexibility previously described for the consultant/low-bid contractor approach are created.

Commodity (COTS): Contracting for the acquisition of commodities is applicable to ITS contracting to the extent that an agency is procuring commercial-off-the-shelf

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[9] Federal Register, Part II, Department of Transportation, Federal Highway Administration, 23 CFR Parts 627. et al. Design-Build Contracting; Final Rule, Tuesday, December 10, 2002.

(COTS) products. These may include field equipment such as variable message signs, traffic signal controllers, radios, or computers. From the perspective of the guidelines being produced in connection with this NCHRP project, consideration of commodity procurements is limited to COTS software and systems. As discussed earlier, the use of mature, tested software and systems is preferable to the acquisition of a new custom designed system. COTS procurements are quite different from consultant or low-bid contractor selections. The procurements are based on price and functionality of the COTS products. The management of a COTS procurement is also quite different from those discussed above. Acquisition focuses on delivery times, and verification of functions and features. The systems engineering process is not applicable to a commodity type application except to the extent that the process is used to define, validate and verify requirements.

The power of the COTS approach is well documented. As long ago as 1987, Frederick Brooks in his classic essay[10] stated "Any such product is cheaper to buy than to build afresh. Even at a cost of one hundred thousand dollars, a purchased piece of software is costing only about as much as one programmer year. And delivery is immediate at least for products that really exist, products whose developer can refer products to a happy user. Moreover, such products tend to be much better documented and somewhat better maintained than home-grown software."

In cases where the COTS product is to be embedded into a system containing additional hardware and software, its installation may still require the use of a systems integrator or systems manager for its installation, adaptation and testing. An advanced traffic management system including the development of a control center with operator workstations and displays, but using COTS traffic management software, is one such example. This approach was used by the State of Utah when it adapted the Navigator traffic management software initially developed for the State of Georgia, for use in Salt Lake City. The Navigator software was implemented in Salt Lake City using a systems manager contract, in which the contractor was required to acquire and modify the Navigator software to meet the requirements of the new installation. Thus COTS software served as the basis for the implementation of a new system using a traditional form of system development.

However, a simple portable dynamic message sign system using COTS software along with portable signs provided by the same manufacturer would not require systems manager assistance. Because this report focuses on the development of complex systems, the commodity procurement is not considered in the comparison of procurement alternatives with the systems engineering process.

Consultant Services: Work provided by consultants is limited to provision of personal services. The use of consultants during the development of an ITS system has already been discussed in the context of the consultant/contractor, systems manger and design-

[10] Brooks, Fredrick P., "No Silver Bullet" Essence and Accidents of Software Engineering", from IEEE Computer; 20,4,10-19; April, 1987, and reprinted by Kemerer, Chris F., "Software Project Management Readings and Cases", Irwin McGraw-Hill, New York, 1997, Pg 10.

build forms of work allocation. Some of the ways in which consultant contracts may be used include:

- System design and installation support – These services are typically provided for the purpose of developing a package of plans, specifications and estimates (PS&E) that serves as the basis for the selection of a low-bid and design-build contractors.
- Inspection - Inspection services might be provided in connection with construction activities and other contracting services provided by others.
- Design – Consultants might prepare designs for ancillary aspects of the ITS system including designs for installations of field equipment, control centers, roadway modifications, etc.
- Documentation and Training – Consultants other than the contractor responsible for the system acquisition might be employed to train agency personnel on the general principles of the technology with which they are working. Consultants might also be employed to develop documentation such as policy and procedures manuals for the use of ITS systems.

Thus consultant services are a key element of a system acquisition when low-bid and design-build contractors are used for the system implementation. Consultant services are used not only for initial design, but also to supplement the development activities during the system implementation.

Outsource Contractor: Outsourcing is the process by which organizations (public or private) use external providers to manage or maintain certain aspects of their business. Outsourcing is increasingly used by the public sector in response to citizen's demands for expanded services and due to the difficulty of competing with the private sector for highly skilled personnel. In some cases, outsourcing may result produce cost savings because of the outsource contractors' access to specialized resources including equipment, personnel and facilities. Contractors may also be able to deliver the needed outsourcing support in a more flexible fashion by using streamlined contracting procedures, the absence of artificial constraints on personnel ceilings, and the ability to trade off capital expenditures with recurring maintenance and/or operating costs. As a result of these perceived benefits, government outsourcing is increasing at a rapid pace. For example, it is estimated that the overall Federal government's outsourcing will increase by approximately 16% between fiscal years 2001 and 2006, to a level of $13.2 billion for IT outsourcing alone.[11] Total outsourcing expenditures including all types of support are significantly higher.

"But outsourcing also generates controversy. The results are mixed-some outsourcing initiatives fail to produce the expected results-and many agency managers see it as a means of government downsizing, an abdication of accountability or simply a risky

[11] "Government Outsourcing Grows Fastest of all Sectors", Washington Technology, http://www.washingtontechnology.com/, Dec. 3, 2004.

financial maneuver."[12] Difficulties encountered include lack of familiarity with the process, resistance from employee unions, changing political agendas, and uncertain support of budgetary requirements spanning multiple fiscal years. As a result, successes such as those experienced by Chicago's Public Housing Authority, the City of Phoenix's municipal services and the State of Pennsylvania's data processing functions, are offset by problems that have been experienced by the City of San Diego, and the State of Georgia.

Maintenance services are the most frequently used type of outsourcing in ITS. However, this form of contracting has also been used to provide system operations. The best known example of operations and maintenance outsourcing, is the INFORM system a regional traffic management system managed by the New York State DOT for the Long Island roadway system. INFORM operates 24 hours per day, seven days a week, and covers approximately 180 miles of roadway. This extensive system includes 113 variable message signs, 84 CCTV sites, 81 video detectors, 2,400 loop detectors, 75 ramp meters, 177 traffic signals, 2 highway advisory radio sites, 9 weather monitoring stations and 15 Help vehicles.[13] The system engineering, operations and maintenance is outsourced to consultants and contractors and administered by State personnel. New York State personnel have concluded that the annual cost of outsourced operations and maintenance are equal to 7 to 10% of the system's present worth. They have determined that the present worth values are $1.0 million per freeway centerline mile and $600,000 per arterial centerline mile. They emphasize the importance of continuous reevaluation of cost escalation due to system expansion and normal inflation, to ensure that operations and maintenance budgets keep pace with system requirements.

In some cases the agency will outsource its entire requirement for the implementation of a particular capability. This form of outsourcing is designated "Performance Based Services". It is up to the contractor to furnish and install the system required to provide that capability in the manner needed to meet the service requirements defined by the agency. In many cases, systems provided with this turnkey form of outsourcing remain the property of the contractor since the agency is providing financial support required to receive a certain level of services rather than paying for the acquisition of a system. Each of these types of outsourcing is summarized in this section.

Maintenance Outsourcing**:** System maintenance can be performed by the agency, it can be outsourced to a maintenance contractor, or a hybrid approach can be used, in which some system elements are maintained by the agency and others by a contractor. The hybrid approach is typically used by agencies experienced with the maintenance of field equipment (variable message signs, cameras, detectors, etc.), but with little capability in the maintenance of computer and telecommunications hardware and software. In these cases, field hardware is maintained by the agency and the central system is outsourced to

[12] "Outsourcing in Government: The Path to Transformation", Accenture, http://www.acenture.com/xd/xd.asp?, Posted June 2002.
[13] "DRAFT Case Study INFORM (10-29-04)", TMC Business Planning and Plans Handbook, TMC Business Models, Federal Highway Administration, Washington, DC http://tmcpfs.ops.fhwa.dot.gov/cfprojects/

a maintenance contractor. Central system maintenance is often (but not always) performed by the contractor that installed the system because of their familiarity with the details of complex software code and complex wiring. This approach is recommended for central system maintenance unless the contractor's work has been unsatisfactory, or sole source contracting to the system provider is precluded by state contracting policies. Whether outsourced or performed by the agency, maintenance activities should include many of the same systems engineering activities that are performed during the installation including:

- **Configuration Management, which** must be performed throughout the life of the system in order to facilitate maintenance activities and to track equipment performance. A good configuration management system will enable the evaluation of equipment reliability and the determination of the times at which equipment should be replaced because of increasing failure rates. Whether or not maintenance is outsourced, a Configuration Control Board (CCB) is required to control the introduction of new system features and to track maintenance activities that affect the overall system configuration.

- **Risk Management:** It is important to perform risk management planning and risk mitigation during the maintenance phase of the project. Since the maintenance phase of the project includes risks that are different from those that exist during the construction phase, the risk management process must be initiated from the beginning. Maintenance risks are associated with items such as catastrophic failures, availability of spares, contractor performance, and unanticipated equipment reliability problems.

- **Validation and Verification:** Validation and verification processes are relatively straightforward for the maintenance phase. Validation is typically an operational activity and is not performed by the maintenance contractor. Verification should be routinely performed by the maintenance contractor during repair and replacement activities. In the event that maintenance is outsourced, the agency should spot-check the contractor's verification activities to ensure that they are performed in accordance with the agency's requirements.

- **Metrics:** Maintenance metrics are different from those used during system installation. Metrics track both contractor performance and system performance. Typical metrics for the contractor include contractor's response times, repair times, employee turnover rate, extent of failed components, etc. Typical system metrics include availability, mean times between failures, replacement equipment and component availability and cost, etc.

In the event that maintenance activities are outsourced, the requirement to perform these crosscutting activities must be included in the maintenance contract.

<u>Operations Outsourcing:</u> While operations are outsourced less frequently than maintenance, this form of outsourcing is not unheard of. Operations services for the

INFORM system are outsourced to a private firm that furnishes a staff of approximately 26 full time equivalents (FTEs). Through contracting, the State places the complete staffing burden (recruiting, hiring, training and firing) on the private contractor.

Performance Based Services: Contracts for performance based services are initiated by agencies that do not want to be involved with the implementation of a complex system or service, but would prefer to contract on the basis of outcomes rather than specifying the manner in which a particular system or service is to be provided. In other words, the agency is contracting for an end result, rather than defining the system that is needed to produce the desired result.

This form of contracting is often used when there as an opportunity for the private sector to leverage the public sector funding by providing revenue generating, value-added services to travelers. Two examples of these types of services include traveler information systems and commercial vehicle systems. The advantages and disadvantages of performance based contracting are summarized in Table 1

Consideration	Advantages	Disadvantages
Contractor Selection	Simplified, in that it is based on offeror's capabilities and financial proposal	Difficult to evaluate and compare alternate technical approaches
Ownership	System (if any) is owned and operated by the contractor. No need for agency to consider operations and maintenance.	In the event that the contractor is cancelled, the agency's investment in system development is lost
Intellectual Property	No need to negotiate complex intellectual property rights agreements. Contractor owns intellectual property	Innovations suggested by agency typically become property of contractor unless otherwise specified

Requirements	Requirements defined in terms of outcomes, rather than outputs. Theoretically, outcome-based contracts ensure the achievement of the desired end product.	Difficult to define and measure outcomes. For example, the outcome for a traveler information system may be the percent of traffic that diverts during an incident due to the availability of traveler information. May be impossible to measure.
Priorities	Agency's priorities are typically improved mobility and safety, or reduced transportation costs	Contractor's priority is profitability Agency and contractor priorities may be different.
Successes	Private sector continues to pursue performance-based contracting opportunities	To-date, few successes to report. Most contracts of this nature have failed due to overly optimistic financial projections.

Table 1. Assessment of Performance-Based Contracting

From this table, it is evident that in some specialized situations, performance based contracting may be an attractive contracting approach. However, there are many potential pitfalls associated with defining and achieving desired levels of performance, with the result that this form of contracting should be used very selectively. In addition, it is essential that an exit strategy be developed for situations in which performance-based contracting is being considered. It is important to decide in advance whether (and how) the agency will continue to offer a particular service in the event that the relationship with the outsourcing contractor must be terminated.

Services: Contracts for other forms of services are frequently awarded during the life cycle of an ITS system. Technically, many of these other services may also be considered consulting services. The differentiation is made here to identify services that are outside the mainstream of system development. There are many forms of general services for which an agency may contract during an ITS life cycle. Representative services include:

- Inspection: Consultants may be employed to inspect the work of electrical and construction contractors. While field inspection is generally performed by agency staff, the requirements for inspection of ITS installations may be specialized and fall outside of the knowledge and capabilities of the traditional inspectors. For this reason, consultant assistance may be employed.
- Independent Verification and Validation (IV&V): These services are typically provided by an outside organization employed to examine the software, hardware and products being provided by the ITS contractor. IV&V services typically also assess the degree to which the contractor is adhering to the principles of systems engineering including such items as configuration management, quality assurance, testing, etc.

- Data Collection and Entry: Services are often required in connection with an ITS implementation for the collection and entry of data required to support the system operation. A wide variety of data may be required including:
    - Traffic count data to support the development of traffic signal timing plans
    - Traffic flow data required to verify the operational effectiveness of the system during acceptance testing.
    - As built data that describes the installation
    - Survey data required for placement of vehicle detectors and/or cameras
    - Geographic information to be used in the preparation of graphical user interfaces
- Outreach: A variety of outreach services may be employed for public relations and to inform other agencies of the system development that is underway.
- Independent Service Providers (ISPs): Contracts will be negotiated with a variety of service providers for Internet website hosting, telecommunications service, leased lines, etc.
- Staff supplements: Consultant services may be employed to supplement the existing agency staff. The consultant may provide employees that perform any of the functions associated with a system development including such items as contractor oversight, documentation reviews, testing and coordination.
- Training: Although the installation contractor is usually contractually responsible for providing training related to the operation and maintenance of the system being acquired, consultant services may be required to provide supplementary training of a more generalized nature. Consultant training may be provided to acquaint agency staff with the general principals of system management and traffic operations. It may also be provided to describe the general principles of system development including such items as configuration management, concepts of operations and risk management.

The dimensions of contracting discussed here are based on the considerations associated with the acquisition of a particular ITS system. However, these principles are also applicable to the acquisition of a broad range of services including consulting services (design, inspection, etc.), outsourcing, and other services. The process of contracting for services (as opposed to products or construction) is well defined. It is based on the use of a negotiated contract as the method of award. Any contract form (phased, task order or purchase order) may be used, and the contract type may be fixed price, cost reimbursable, incentive or time and materials. The criteria used for selection of contract form and contract type are the same as those that would be used for a system implementation.

METHOD OF AWARD

The method of award category of contracting defines the criteria used and steps taken to select a contractor to perform the work. The method of award is determined by the form of work allocation that has been selected. As indicated below, there are distinct differences between the various methods of award. These differences should be taken into account when selecting a form of work allocation.

Low-bid: Low-bid contracting commonly referred to as sealed bidding is a contracting method the employs competitive bids, public openings of bids and low price awards. This contracting method must describe the agency's requirements clearly, accurately and completely. Restrictive specifications or requirements that might unduly limit the number of bidders are not allowed. The Invitation for Bid (IFB) generally includes all documents whether attached or incorporated by reference furnished to prospective bidders for the purpose of preparing their bids. Bidders submit sealed bids to be opened publicly at a specific place and time and the bids are then evaluated without discussions with the bidders. Award of the contract is made to the responsive and responsible bidder, whose bid is most advantageous to the agency, considering only price and the price-related factors defined by the IFB.

Negotiation: Unlike formal advertising of a contract requirement which is precise, highly structured method of procurement with one definitive set of procedures, negotiation allows considerable flexibility, permitting the use of a number of different procedures in making awards. Negotiation differs considerably from low-bid procurement. First, proposals are not available for public inspection prior to award. In contrast, under low-bid procurement, public opening of bids is a major step in the selection of a contractor.

Second, the agency is not required to reject proposals that vary from the Request for Proposals (RFP) requirements but may consider such proposals. Thus, negotiation does not involve the concept of responsiveness developed in low-bids where the agency is prohibited from considering a bid that deviates from the IFB. This prohibition is not applicable to negotiation where the agency is permitted to conduct oral or written discussions with offerors whose proposals vary from the RFP.

Third, the negotiations permit discussions between the parties and modifications of proposals by offerors while low-bid does not. Finally, under negotiation, the procuring agency's source selection officials have a much greater discretion in selecting the successful offeror for award. They are not required to award to the low bidder but may "trade off" cost to the agency against other factors such as technical performance, management capability, and demonstration of technical capabilities using factors such as staff qualifications and certifications such as CMM in arriving at the source selection decision. Negotiation may be competitive or they may be held with a single organization identified as the conditionally selected offeror. Alternatively, some agencies choose to have very little contact with offerors prior to the final selection.

The negotiated selection is typically based on the evaluation of a technical approach, qualifications and experience as represented in a technical proposal and possible subsequent presentations to the agency. The Federal Acquisition Regulations (FAR) indicates that the negotiated procurement process should consist of a mix of technical, qualifications and cost considerations defined in advance by a source selection authority (evaluation panel). The FAR indicate that: "The source selection authority's (SSA) decision shall be based on a comparative assessment of proposals against all source selection criteria in the solicitation. While the SSA may use reports and analyses prepared by others, the source selection decision shall represent the SSA's independent judgment. The source selection decision shall be documented, and the documentation shall include the rationale for any business judgments and tradeoffs made or relied on by the SSA, including benefits associated with additional costs. Although the rationale for the selection decision must be documented, that documentation need not quantify the tradeoffs that led to the decision."[14]

It must be emphasized that the FAR applies to Federal procurements. State policies and procedures may be more restrictive. Many states require that the consultant selection process be based exclusively on merit as reflected by the offeror's technical proposal and qualifications. Cost negotiations occur following the consultant selection and negotiation of technical terms.

Best Value: Best value selection is most often used for the selection of design-build contractors. The best value selection combines the features of the negotiated and low-bid procurements. During the first step in this process, offerors (contractors) submit their proposed designs for evaluation and negotiation with the procuring agency. Following these negotiations, and the development of an acceptable design, the contractor submits a bid for the design that has been approved. Selection may be made based on the proposal that offers the best value to the procuring agency. However, in many cases, the lowest bid is selected.

Sole Source: Sole source procurement is the direct selection of a contractor without competition. Although this form of contractor selection is discouraged and may be illegal, there are some cases for which it is appropriate including:

- The selection of a contractor that provides unique services or products that cannot be acquired elsewhere. One such example is the lease of telecommunications lines from the local telephone service provider.
- The acquisition of field equipment compatible with existing equipment. A common example would be a modest expansion of a system that currently consists of a homogenous set of existing equipment (controllers, dynamic message signs, weather stations, etc.) Maintaining a homogenous set of field equipment <u>may</u> offer the advantage of a simplified spares policy as well as lower cost maintenance and training.

Because sole-source contracting is associated with a unique set of circumstances, it does not receive further consideration in this report.

[14] Federal Acquisition Regulation FAC 2001-2002 February 19, 2002, Paragraph 15.308.

Contract Form

The contract form defines the manner in which work is authorized. Three contract forms are defined, phased contracts, task order (or indefinite quantity) contracts, and purchase orders.

Phased Contracts: Phased contracts are the conventional form of contracting that is in use for the majority of projects including ITS acquisitions. Phased contracts divide the work into predefined activities. The contractor is authorized to begin work on a particular contract phase through the issuance of a simple letter by the agency. For the purpose of this report, single-phase contracts are a specialized form of phased contracting.

Work may be divided into phases for a number of reasons including:

- Management simplicity – It is easier to supervise the contractor's activities if the work is subdivided into smaller elements that can be more easily monitored.
- Funding – At time of contract signing, inadequate funding may be available for all contract phases. Authorization to begin work on a phase occurs only when adequate funding has been identified.
- Desire to assess contractor's performance – Phased contracts provide the agency with logical decision points at which go/no-go decisions can be made to continue with the current contractor. If contractor performance is unacceptable, new phases can be awarded to another organization.

The distinguishing characteristic of phased contracts is the fact that work is well defined for all contract phases. As a result, this form of contracting is only applicable to the waterfall form of development. It cannot be readily used for the spiral or evolutionary development models.

Task Order (Indefinite-Delivery) Contracts: Indefinite-delivery contracts are used with contracts in which the required supplies and services are unknown at the time of contract execution. They provide a mechanism for the agency to place orders for these supplies and services during the life or term of the contract. In the case of ITS projects, the supplies and services requested are defined in terms of task orders that define the work to be performed by the contractor.

The three types of indefinite-delivery contracts are: Definite-quantity, Requirements, and Indefinite-quantity contracts. The appropriate type of indefinite-quantity contract may be used to acquire supplies and/or services when the exact times and/or exact quantities of future delivers are not known at the time of contract award. These contracts are also known as delivery order contracts or task order contracts. Cost risk and administrative burden is shared between the procuring entity and contractor. These types of contracts *further limit the procuring entity's obligation to only the minimum quantity specified in the contract and permit faster procurement of supplies and services as the contract requirements evolve.

Indefinite delivery contracts are ideally suited to both the evolutionary and spiral development processes, since they permit the issuance of task orders for additional planning, design and implementation services as various evolutionary phases evolve.

Purchase Orders: A purchase order is a form of sole-source contracting used for relatively small procurements. The cap on purchase order contract size varies among agencies, but is typically less than $50,000. Purchase orders are a simple, rapidly executed form of contract that usually contains a standard set of terms and conditions (payment, insurance, cancellation clauses, etc.) and a relatively brief description of the work to be performed. Because this contract form is not applicable to the acquisition of large scale ITS systems, it is not discussed further in this report.

Contract Types

Innovative contracting today is proving to be an acquisition methodology, which is saving more money and enhancing critical mission attainment. It requires structuring all aspects of an acquisition around the purpose of the work to be performed as opposed to how the work is to be performed or broad and imprecise statements of work. It often emphasizes quantifiable measurable performance requirements and quality standards in developing statements of work, determining contract types, incentives, selecting contractors and performing contract administration, including contract monitoring and oversight. Procuring entities are working to provide meaningful incentives for the contractor and the agency to encourage successful contract performance.

Numerous types of contracts are available for use with different types of projects and under various circumstances. Contract types may vary according to the degree and timing of responsibility assumed by the contractor for the costs of performance and the amount of time and nature of the profit incentive offered to the contractor for achieving or exceeding specific standards or goals. Contract types include a range of alternatives from firm fixed price, whereby the contractor assumes full responsibility for the performance costs and any profit or loss, cost plus fixed fee, whereby the contractor has minimal responsibility for the performance costs and the fee (profit) is fixed and time and materials, in which the agency assumes the financial risk for the successful project completion. Other contract types vary, but generally deal with incentives whereby the contractor’s responsibility for performance costs and profit and/or fee incentives are dependent upon the uncertainties associated with the desired outcomes of the procurement.

Performance-based and design-build contracting methods continue to gain popularity in the ITS arena and prove to be both cost efficient and technically superior. These contract methods can combine performance specifications with incentives and penalties to achieve desired results based on the established goals and objectives of the procuring entity and at the same time, place more risk on the contractor. In these methods of contracting, the acquisition is structured around the purpose of the work to be performed as opposed to the manner in which the work is to be performed. The contractor is given freedom to determine how to meet or exceed the procuring agency's performance objectives and quality levels are achieved and payment is only made for services that meet or exceed these levels.

Fixed Price Contracts: Fixed Price contracts place the risk and full responsibility for all costs and profit or loss on the contractor. After award, price under this type contract does not increase regardless of the costs incurred by the contractor during the performance of the contract. This type contract places the burden on the contractor to maintain control of costs and perform in the most effective and efficient manner. The agency on the other hand assumes the least risk and administrative burden. There are types of fixed price contracts that have an award fee or incentives where the award fee is based solely on factors other than a percentage of contract cost, however, the contract type remains firm fixed priced when used with these incentives.

Fixed Price contracts are best used for procuring commercial items and/or supplies or services when a definite functional or detailed specification can be fully defined. In addition, this type contract is preferred when the procuring entity can establish fair and reasonable prices, i.e. when there is adequate price competition, reasonable price comparisons in the marketplace, and available cost or pricing information. There are many variations of fixed price contracts that provide flexibility in the payment of both costs and fees (profits) to the contractor. Variations that are applicable to the development of intelligent transportation systems include:

- **Fixed Price Firm Target:** A fixed-price firm target contract specifies a target cost, a target profit, a price ceiling (but not a profit ceiling or floor), and a profit adjustment formula. This type contract is appropriate when the parties can negotiate at the outset a firm target cost, target profit adjustment formula that will provide reasonable incentives and a ceiling that provides for the contractor to assume an appropriate amount of the risk.
- **Fixed Price with Successive Targets:** This type of contract is a variation of the firm target alternative. It specifies an initial target cost, an initial target profit, an initial profit adjustment formula, a production point at which the firm target cost and profit will be negotiated and a ceiling price that is the maximum that may be paid to a contractor. This type contract is appropriate when cost or pricing is not sufficient to permit the negotiation of a realistic firm target cost and profit before award.
- **Fixed Price Award Fee:** This contract specifies a fixed-price including normal profit for a contractor's effort and provides for periodic evaluation of the contractor's performance against an award fee plan. This type of contract is used when the agency wishes to motivate a contractor and other incentives cannot be used because the contractor performance cannot be measured objectively. It differs from the first two forms of contracting in that the determination of the award fee is subjective, while the target fees are calculated on a formula basis.
- **Fixed price with Economic Price Adjustment:** Fixed-price with economic adjustment contract is a contract that provides for upward and downward revision

of the stated contract price upon the occurrence of specified contingencies. Economic price adjustments are of three general types and are based on established prices, actual costs of labor and materials, and cost indexes of labor and materials. This type contract is used when there is serious doubt concerning the stability of the market or labor conditions that exist during an extended period of contract performance.

Cost Reimbursement Contracts: Cost reimbursement contracts provide for payment of contractor costs, to the extent identified in the contract scope of work or specification. Cost reimbursement contracts establish an estimate of the total cost for the purpose of obligating not-to-exceed funds for the contractor (except at its own risk) without the approval of the procuring entity. Cost reimbursement contracts are used when the procuring entity is not clear as to total cost estimated to perform the work under consideration with complete accuracy. These type contracts place more of the cost risk and administrative burden on the procuring agency and less on the contractor. The contractor's risk is implicit in the fact that a fixed fee will be paid independent of the actual cost of performing the work. Thus, while the contractor is guaranteed a profit (as opposed to fixed price contracts where the contractor can lose money), the profit measured as a percent of total cost can vary considerably.

Cost reimbursement contracts are applicable to ITS developments where the end product cannot be fully defined. This is generally the case for projects involving the development of new or modified software. It is also used for research and development or preliminary exploration or study where the level of effort required is unknown. Forms of Cost Reimbursement contracts include:

- **Cost plus Fixed Fee (CPFF):** This is the most common form of cost reimbursement contracting. The contractor is reimbursed for all costs associated with performing the work plus an audited burden. In addition, the contractor receives a fee negotiated based on the actual cost of performing the work. The fee payment is fixed and does not vary whether the actual cost of the work is higher or lower than the original estimate.
- **Cost plus Incentive Fee (CPIF):** Cost-plus-incentive-fee contract is a cost-reimbursement contract that provides for the initially negotiated fee to be adjusted later by a formula based on the relationship of total allowable costs to total target costs. This contract specifies a target cost, a target fee, minimum and maximum fees, and a fee adjustment formula. This type contract is used for services or development and test programs when a cost-reimbursement is necessary and a target cost and fee adjustment formula can be negotiated that are likely to motivate the contractor to manage the effort effectively.
- **Cost plus Award Fee (CPAF):** Cost-plus-award-fee contract is a cost-reimbursement contract that provides for a fee consisting of a base amount fixed at the inception of the contract and an award amount that the contractor may earn in whole or in part during contract performance. This type contract is used when the work to be performed is such that it is neither feasible nor effective to devise

objective incentive targets on costs, technical performance or the performance schedule.

The Federal Acquisition Regulation (FAR) defines cost reimbursable contracts in the following manner: "Cost -reimbursement types of contracts provide for payment of allowable incurred costs, to the extent prescribed in the contract. These contracts establish an estimate of total cost for the purpose of obligating funds and establishing a ceiling that the contractor may not exceed (except at its own risk) without the approval of the contracting officer."[15] In the event that the costs exceed the estimate, the FAR indicates "However, in the event the work cannot be completed within the estimated cost, the Government may require more effort without increase in fee, provided the Federal Government increases the estimated cost."[16] In other words, if the cost exceeds the initial estimate, the Federal Government is obligated to pay the cost in order to receive the finished product, but is not obligated to pay any additional fee.

This differs from the policy of many states, which apply a contract ceiling (maximum dollar expenditure for cost and fee) to cost reimbursement contracts while requiring the contractor to furnish a completed product. This restriction, effectively converts the contract into a fixed price contract with the additional burden (to the contractor) of supplying the agency with extensive financial backup information to support its invoices. Incentive contract ceilings requiring completion of work should be avoided and fixed price contracts used in their place, since these types of "hybrid" CPFF contracts capture the worst features of incentive and fixed price contracts. This approach should only be used if the agency is willing to accept a partially completed project when the contractor's expenditures have reached their ceiling amounts.

Time and Materials Contracts: Time and materials contracts allow for procuring supplies or services on the basis of direct labor hours at agreed to fully burden fixed hourly rates and materials at cost, including material handling fees as a part of material costs. Time and material contracts are generally used when it is difficult to accurately estimate the extent and duration of the work to be performed by the contractor. This type contract provides no positive profit incentive to the contractor for cost control or efficiency and places the majority of risk on the procuring entity requiring extreme care to ensure the proper level of contract monitoring and oversight is obtained.

Incentive Contracts: Incentive contracts establish reasonable and attainable targets that are clearly defined and communicated to the contractor and include proper incentive arrangements designed to motivate contractor efforts that might not otherwise be emphasized and discourage contractor inefficiency and waste. When predetermined formula-type incentives on technical performance or delivery are included, increases in profit or fee are provided only for the achievement that surpasses the targets, and decreases are provided to the extent that such targets are not met. The incentive increases

[15] "Federal Acquisition Regulation", Paragraph 16.301-1, General Services Administration, Washington, DC, September 2001.
[16] "Federal Acquisition Regulation", Paragraph 16.306 (d)(1), General Services Administration, Washington, DC, September 2001.

or decreases are applied to performance targets rather than minimum performance requirements.

When considering the possible use of incentives, it is important not to be misled by the positive results produced by incentives that have been used to encourage early completion of civil construction contracts. The same degree of schedule compression cannot be achieved with software-based projects. As a result, incentives can have only a modest impact on overall cost and schedule. This fact is well documented by the software industry. For example, one source indicates that "you can compress software development schedules 25% of nominal, but no more."[17] Theoretically, schedule compression on labor-intensive software and systems integration projects can be achieved by merely adding additional staff to the project. However, this technique has the unfortunate impact of increasing the schedule, due to the need for increased coordination and other forms of interaction among the programming team. The need for communication among members of the programming team grows at a faster rate than the size of the team. In addition, new members of the team must be mentored by existing team members, with the result that the productivity of the most important team members is further reduced. The only proven technique for schedule compression is reduced functionality. This can only be accomplished with collaboration and contracting flexibility; two features that are difficult to implement when fixed price contracting is used.

Incentives are effectively built into the fixed price and cost reimbursement contracts described above. In the case of these contracts, the possible variations in fee are essentially intended to offer incentives to contractors to meet or exceed the contract requirements. Since it is to the procuring entities advantage for the contractor to assume substantial cost responsibility and an appropriate share of the cost risk, fixed-price incentive contracts are preferred when costs and performance requirements are reasonably certain.

Delivery incentives should be considered when the delivery schedule is critical. Incentives defined at the time of contract signing permit the contractor to develop a project management plan that will ensure that the schedule is met. Explicit incentives may be defined separately from the contract terms for contractor reimbursement. These incentives and disincentives include award of early completion bonuses and late delivery penalties.

Late delivery penalties may be defined in terms of liquidated damages, which are a penalty that is assessed for late delivery of a system, when the actual damage to the agency due to the delay is difficult to ascertain. However, when considering the use of liquidated damages as a disincentive for late delivery, it is important to recognize that:

- Courts generally do not enforce liquidated damages that are intended to serve as a penalty or are far in excess of the amount of damages the parties may reasonably

[17] Royce, Walker, "Software Project management – A Unified Framework", Addison-Wesley, Reading, Massachusetts, 1998, pg. 18

forecast. For this reason, the agency must be prepared to justify the value of the damages it intends to assess.

- On negotiated contracts, contractors will often request the use of symmetrical contract provisions. In other words, contracts with provision for a certain level of liquidated damages (say a penalty of $500 for each day the contract is late), be offset with an equal bonus (say a payment to the contractor of $500 for each day the contract is early).

When appropriately applied, this combination of incentives and disincentives can be a powerful motivator to contractors providing the work does not include a significant percentage of new software development, and a high level of uncertainty regarding the system requirements.

Performance-Based Contracting: Performance based contracting is a form of contractor incentive or disincentive, in that payments made based on the outcomes resulting from the system installation. Contracting today and in the foreseeable future will place special emphasis on what the agency wants performed by the contractor, (outcomes), versus the manner in which the work should be performed. In other words, more general work scopes, and more specifics on final system performance defined in measurable terms. Performance standards (i.e., quality, quantity, timeliness) will then be assigned to tasks, and an associated quality assurance (QA) plan that describes how the agency will measure contractor performance against the standards will be developed. Positive and negative incentives based on the QA plan measurements can then be used to adjust contractor's payments, in order to ensure a high level of performance. However, performance-based contracting must be used carefully, because of the difficulty of providing definitive goals that will not lead to subsequent disputes with the contractor. One unsuccessful example that illustrates the potential pitfalls of performance-based contracting occurred when a state agency contracted for the installation of an adaptive traffic signal system. The contractor agreed to a performance-based contract in which the fee would be based on the percent reduction in delay that resulted from the operation of the new system. However, a significant increase in traffic demand occurred during the system installation period that negated any potential benefits that might have been produced by the system. The contractor claimed that it was eligible for the entire incentive payment and was able to produce simulation results in support of this claim. The state claimed that the traffic demand was due, in part to the late delivery of the system, which was caused by the contractor.

The importance of selecting the proper type and method of contracting for ITS procurements cannot be over stated. The primary concern for using innovative contracting approaches is the reduction in time and resources from project planning through construction and final acceptance and completion. By using the most effective type contract that focuses on innovation, the procuring entity will provide real benefits in terms of cost, time and quality.

RELATIONSHIP BETWEEN CONTRACTING AND SYSTEMS ENGINEERING

Each of the four dimensions of procurement, to a greater or lesser extent, has an impact on the manner in which systems engineering process can be applied. The challenge is to select a procurement approach that:

- Compatible with the agency's capabilities (including experience) and personnel resources needed for project management and support.
- Appropriate for the project characteristics including the project's complexity and uniqueness
- Supports the systems engineering process, and the principals of high technology project management.

Many of these issues will be considered during Task 5 of this project. The purpose of this task 4 report is limited to consideration of the relationships between procurement and systems engineering. These relationships will be discussed in terms of the four dimensions of procurement and the system engineering process (including the steps of the "V" diagram, the alternative processes and the cross-cutting activities), along with the principles of project management.

The details of the relationships between the work allocation and the systems management/project management process and principles are presented in the appendix and summarized here.

Work Allocation

Work allocation has one of the most significant impacts on the relationship between systems engineering and procurement. For example, constraints on contractor participation in the process prevent active participation of low-bid contractors in the early stages of system planning and design that are essential elements of the process. These restrictions are portrayed in the summary of responsibilities and relationships presented in Tables 2 and 3 below. Commodity procurements and services contracts are not included in this comparison since they are not directly related to the system acquisition. Tables 2 and 3 present a simplified view of the process, but only to define the fundamental relationships between the procurement and systems engineering processes.

In this table, the reference to an optional activity ("O") means that the agency can optionally select the assignment for a given responsibility. It is not intended to indicate that execution of the activity is optional. For example, either the agency or the consultant might perform the inspection activity. It is up to the agency to determine who will be assigned the responsibility for performing this work. The steps for which an N is entered, indicates that the work is performed by an organization other than the one for whom the data is entered. For example, the N for the systems integrator in the Requirements row, is provided as an indication that the systems integrator will not be defining requirements, but either the agency or its consultant will be performing the work

System Engineering and Project Management Processes	Consult./Contractor		Systems Integrator	Systems Manager	Design-Build	Outsource Contractor
	Consult.	Low-Bid Contractor				
Planning (concept of operations)	PO	N	N	PO	N	N
Requirements	P	N	N	P	Partial[18]	N
Design	P	N	N	P	Partial[19]	P
Implementation	N	P	P	P	P	P
Testing	S	P	P	P	P	P
Risk Management	PO	N	N	P	P	P
Configuration Management	N	P	P	P	P	P
Tracking Metrics	SO	N	N	P	P	P

Table 2. Relationship Between the Systems Engineering Process and Contract Work Allocation

Key:
P = Primary (lead) responsibility
S = Supporting responsibility
PO = Primary responsibility an option – either could serve in the lead role
SO = Support optional
N = Not a participant

Table 2 implicitly illustrates the relative strengths and weaknesses of the various forms of work allocation. For complex systems it is desirable for the implementer to participate in the early stages of planning and requirements definition to ensure that the organization responsible for developing the software and acquiring (or specifying the hardware) has a complete understanding of the agency's desires and needs. Only the systems manager form of work allocation addresses this need.

Well-defined systems do not necessarily require the implementer's early participation in the process. However, even for these types of systems it is desirable for the implementer to have as much of the systems engineering responsibility as possible during the implementation stage of the contract. Either the systems manager or design-build forms of work allocation include this level of participation.

[18] High-level requirements are developed by the procuring agency, typically with consultant support.
[19] Typically a 30% design is developed by the procuring agency with consultant support and used as the basis for the design-build contractor selection and contract.

Project Management Principles	Consult./Contractor		Systems Integrator	Systems Manager	Design-Build	Outsource Contractor
	Consult.	Low-Bid Contractor				
Collaboration	H	L	M	H	M	M
Off-the-Shelf Solutions	N/A	Possible	Possible	Possible	Possible	Likely
Prequal.-Certification	H	L	H	H	L	H
Organization	N/A	L	H	H	M	M

Table 3. Relationship Between the Project Management Principles and Contract Work Allocation

The high (H), medium (M) and low (L) ratings in this table refer to the degree to which the project management principles can be followed with the selected form of contracting.

The ratings in this table were assigned on the following basis:

- Collaboration is the degree to which the contractor and agency can work together to arrive at an acceptable system implementation. The low-bid contractor's relationship with the agency is frequently confrontational, and the relatively low profit margins and fixed price nature of the work precludes positive collaboration for this contracting work allocation. In all other cases, relatively high levels of collaboration are possible, except that in the systems integrator's case, collaboration during the planning and design stages of the contract have not been possible, and for this reason a medium rating was applied.
- In all cases, it is possible to specify off-the-shelf solutions for the system implementation, so this is not a consideration in the identification of a preferred contracting technique.
- Prequalification/certification can be readily implemented and used during the selection process for negotiated procurements. Although prequalification is frequently used as part of the low-bid contracting, it is not as effective because of the more restrictive definition and evaluation of the contractor's capabilities. For this reason, work allocations involving low-bid were assigned a low rating.
- The organizational category in this table is a rating of the ease with which the software developer/systems integrator can interact directly with agency personnel. The evaluation of this category is based on the likelihood that the organization responsible for these aspects of the system implementation is likely to serve as a prime contractor or subcontractor. Historically, low-bid procurements are led by electrical contractors, and for this reason, an "L" rating has been given. An "M" rating is given to the design-build alternative because historically, large contractors performing this work have done so with a focus on the "big ticket items of construction and field equipment. As a result, the software and system integration aspects of the contract (whether performed by the prime contractor or a subcontractor) tend to receive less attention during the performance of the work.

This table also demonstrates the fact that the systems management work allocation is most applicable to the principles of ITS project management. Here again, the systems integrator, design-build and outsourcing methods are also acceptable.

Method of Award

The relationship between the method of award and the systems engineering and project management processes is based on the capabilities and flexibility of the award alternatives. The low bid alternative requires that a contract award be made exclusively on the basis of price to prequalified bidders with responsive bids. This "black and white" selection approach prevents agencies from selecting contractors with the best certifications and systems engineering qualifications. But more significant the low bid alternative prevents application of the principles of collaboration and evolutionary system development. As a result, the low-bid alternative is only applicable to systems that can be fully specified, will not experience scope creep, and for which the waterfall development process is appropriate. This is not a surprising conclusion, since the work allocation alternatives are directly related to the method of award. As the name implies, the low-bid contractor is based on a low-bid selection process. The design-build alternative utilizes the best value method of procurement, while all of the other alternatives are based on the use of negotiated contracts.

Contract Form

Here again, there is a strong relationship between the contract form and the work allocation. It is possible to use the phased contracting approach with the consultant/low-bid contractor and design-build alternatives. However, the task order and other versions of indefinite quantity contracting can only be used with the systems manager and systems integrator alternatives.

As previously indicated, task order contracts are most appropriate for application of the evolutionary development model. Thus, the use of this model, is restricted to the systems manager and systems integrator form of contracting.

Contract Type

The contract type is the basis for allocating financial risk, and influencing contract performance. It is an explicit technique for defining agency priorities, influencing contractor behavior and managing uncertainties. For this reason, contract type can be a valuable project management tool. The value of this tool for project management is directly related to the range of alternatives that can be applied. The range is defined in Table 4 for each type of work allocation. The work allocation for which a given contract type may be used is indicated by an X. Blank cells in the table indicate that a relationship between the two cannot be established.

Contract Type	Consult./Contractor		Systems Integrator	Systems Manager	Design-Build	Outsource Contractor
	Consult.	Low-Bid Contractor				
Fixed Price	X	X	X	X	X	X
Cost Reimburse.	X		X	X		
Incentive	X	X	X	X	X	X
Time and Materials	X		X	X		

Table 4. Relationship Between the Contract Type and Contract Work Allocation

SUMMARY AND CONCLUSIONS

This report has summarized three complex subjects; systems engineering, project management and procurement. It has then defined the relationship between the three by indicating the impact of procurement approaches on the application of the systems engineering and project management process. The discussion highlighted the following principles and relationships:

- Implementation of ITS projects is quite different from the implementation of civil works. It is necessary to select a systems engineering process, a step that will influence the selection of contracting alternatives.
- The systems engineering development model selected for ITS projects is directly related to the system's complexity.
- Off-the-shelf solutions should be used whenever possible.
- The need for collaboration influences the contracting methodology selected.
- Contracting approaches that work well for civil engineering projects are not equally applicable to ITS.
- The interrelationships among the four dimensions of the contracting must be thoroughly understood. These relationships are summarized in the matrix of Table 4.
- Incentives should be used cautiously, but can be useful in the management of ITS acquisitions.

Work Allocation	Method of Award (Contract Form => / Type =>)	Phased: Fixed Price	Phased: Cost Reimb	Phased: Incentive	Phased: T&M	Task Order: Fixed Price	Task Order: Cost Reimb	Task Order: Incentive	Task Order: T&M
Low-bid Contactor	Low-Bid	X		X					
	Negotiated								
Systems Manager	Low-Bid								
	Negotiated	X	X	X	X	X	X	X	X
Systems Integrator	Low-Bid								
	Negotiated	X	X	X	X	X	X	X	X
Design-Build	Low-Bid	X		X					
	Negotiated								
	Best Value	X		X					
Outsource Contractor	Low-Bid	X		X					
	Negotiated								
	Best Value	X		X					

Table 5. Interrelationship of Procurement Model Components

The four components of the contracting framework are influenced by the work allocation, which in part, is determined by the systems engineering model, the system and agency characteristics. These relationships are summarized in Table 6.

Work Allocation	**Key Considerations: Systems Engineering**	**Key Considerations: Project Management**	**General Comments**
Consultant/Low-Bid Contractor	• Only applicable to waterfall model	• Eliminates possibility of collaboration and risk management	• Use should be restricted to well-defined systems
Systems Manager	• Used with any systems engineering model. • Single contractor responsible for planning, design, implementation, and testing	• Permits use of collaboration and risk management • Increased flexibility for use of contract form • Permits qualification-based selection	• Additional contracting burden placed on agency
Systems Integrator	• Used with any systems engineering model.	• Permits use of collaboration and risk management • Increased flexibility for use of contract form • Permits qualification-based selection	• Additional contracting burden placed on agency • Requires additional consulting assistance

<table>
<tr><th rowspan="2">Work Allocation</th><th colspan="2">Key Considerations</th><th rowspan="2">General Comments</th></tr>
<tr><th>Systems Engineering</th><th>Project Management</th></tr>
<tr><td>Design-Build</td><td>• Most applicable to the waterfall model.
• Possible to include other models, but their application would be the responsibility of the contractor.</td><td>• Only moderate collaboration and risk management possible.</td><td>• Most applicable to systems with time constraints and requirement for continuity between the design and implementation</td></tr>
<tr><td>Commodity (COTS)</td><td colspan="3">For large systems, may be combined with one of the work allocation processes above (for example, the. COTS product is acquired in the same manner as any other system component.)</td></tr>
<tr><td>Outsource Contractor</td><td>• Most applicable to the waterfall model.</td><td>• Only moderate levels of collaboration possible</td><td>• Difficult to define and measure outcomes</td></tr>
<tr><td>Services</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Table 6. Summary of Considerations in the Selection of Work Allocation

The considerations discussed here will be used in the development of the procurement guidelines to be prepared during Task 5.

APPENDIX H

TASK 5 WORKING PAPER

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BACKGROUND

The successful procurement of Intelligent Transportation Systems (ITS) is a challenging task for state and local agencies. The procurement process must be flexible to accommodate the uncertainties of complex system acquisitions, while at the same time rigid enough to ensure that the responsibilities of the participants are fully defined and their interests protected. This process should also ensure that the most qualified organizations are selected for the system implementation.

The Transportation Research Board (TRB) through the National Cooperative Highway Research Program (NCHRP) has initiated the development of a Guide to Contracting ITS Projects (Project 3-77). This guide will highlight best practices and recommend contracting strategies and contract types, terms and conditions for the planning, design, implementation, integration, system acceptance, warranty, maintenance, and upgrade of ITS.

The activities outlined in the scope of work for this project are:

- Task 1 – Review of Transportation and Technology Literature
- Task 2 – Look at Other Industries
- Task 3 – Categorize ITS Projects
- Task 4 – Systems Engineering Process
- Task 5 – Recommend Contract Types
- Task 6 – Prepare a detailed Outline of the Guide
- Task 7 – Prepare the Guide
- Task 8 – Submit Final Report

The objective of this Task 5 Working Paper is to describe the process of planning and executing a system procurement. However, procurement planning cannot be performed in isolation, and for this reason, the Task 5 activities also consider the initial planning activities that must precede procurement planning (designated project planning in this report). Since this project is concerned with procurement rather than the overall subject of ITS project management, the work presented in this task emphasizes the contracting rather than planning aspects of the process.

The procurement aspects of the planning process described in this report is accompanied by a decision model that has been developed to assist agencies in the selection of the procurement alternative best suited to their agency's capabilities and the characteristics of the system being considered. This model is presented at the appropriate point in the procurement planning section of the report. It describes the results of the decision model validation that was based on the application of the model to a number of real-world examples presented at the conclusion of this report.

Because the planning and procurement processes are made up of a number of interdependent activities, it is important both to understand their contents as well as their interrelationships. For this reason, each activity is described in the sequence in which it is to be performed.

THE PLANNING AND PROCUREMENT PROCESS

The activities that should be performed prior to the actual procurement of services or equipment can roughly be divided into the two major categories of Project Planning and Procurement Planning. See Figure 1. Each of the blocks in the figure is defined in the following text. The block titled “Procurement Planning” delineates the specific focus of this NCHRP project. This block represents the Decision Model as depicted in detail by Figures 4 and 5 and supporting text. Figure 1 emphasizes how the Decision Model developed under this project fits within the larger project and procurement planning processes. While these larger processes are not specifically part of the scope of this effort, this Task 5 paper addresses the steps of each in high-level detail to provide the context under which the Decision Model should be executed.

PROJECT PLANNING

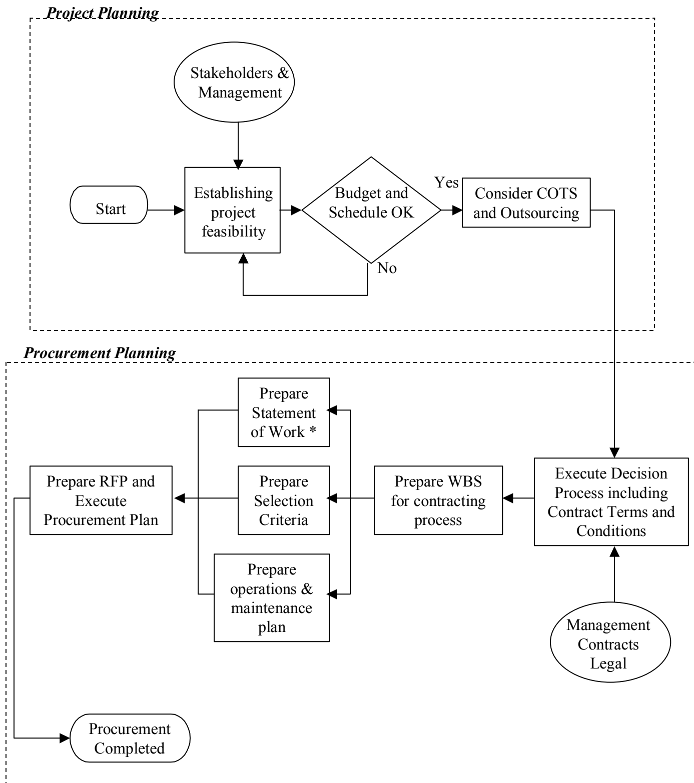
Project planning is performed to ensure that the procuring agency and its stakeholders "have their act together", prior to the initiation of a formal and expensive (at least to the contractor) procurement activity. Project planning is intended to answer the following questions:

- How much will the system cost and can we afford it?
- Do we have a reasonable schedule, or are our deadlines unrealistic?
- Do we have adequate personnel (both numbers and skills) to manage and support the development?
- Does everyone share the same vision for the system? Is there universal agreement regarding the functions to be performed by the system?

Individuals involved in the planning process must work hard to ensure that all of these difficult questions are answered. Optimism is inappropriate at this stage of the process. Funding or schedule shortfalls can only be resolved in one way; reduced project scope. Reductions in scope may include reduced system functionality or reduced geographic coverage or both.

Once an initial high level definition has been developed, it is then possible to address some of the fundamental issues associated with the procurement: Should outsourcing be considered? And can commercial off-the-shelf (COTS) products be used? These issues appear at this point in the planning process since they have a fundamental impact on the manner in which the procurement is defined.

Figure 1. The Planning Process



* May also include plans and specifications as required by the selected contracting alternative

Establishing Project Feasibility

The first step in the project planning process is establishing the feasibility of the project. This is not a trivial process. It involves establishing a team of stakeholders to develop an initial vision and to define initial project phases based on priority functionality. Constraints are also identified as well as a rough order of magnitude (ROM) cost, schedule, and resource estimates. Assuming project feasibility can be established, project initiation can proceed into project planning. Project planning involves preparation of a project management plan and developing a procurement strategy consistent with an applicable system development process.

This phase of the project planning includes two steps; the development of a project scope, and determining whether the estimated cost and schedule for performing the work can be accommodated by the agency's available financial resources and time schedule requirements. If this process concludes that the project costs exceed the agency's budget capabilities, or the schedule is too long, it will be necessary to reduce the project scope. There is no other solution to this problem.

Project Scope: Scope planning is the process of progressively elaborating and documenting the project work that will be necessary to produce the final product. It starts with the initial project description and the initial definition of constraints and assumptions. The project description incorporates project requirements that reflect agreed-upon agency needs and the conceptual project design that meets requirements.

The outputs of scope planning include a project scope statement and possibly a scope management plan. The scope statement identifies both the project objectives and the project deliverables, and forms the basis for reaching a common understanding of, for example, functions, geographic coverage, and participants. The scope statement also provides a documented basis for future project decisions and for developing a common understanding of the project scope among all stakeholders.

Scope definition involves subdividing the major project deliverables into smaller more manageable components in order to:

- Improve the accuracy of the cost, duration, and resource estimates,
- Define a baseline for performance measurement and control, and
- Facilitate clear responsibility assignments.

Proper scope definition is critical to project success. The results of inadequate scope definition almost certainly mean wasted resources, rework, and extended project times.

Initial Estimates of Cost and Schedule: Cost estimation and tracking techniques are used to estimate the cost of tasks and to roll those costs up to total project costs. They require input information that provides Basis of Cost parameters from prior experience. They are also used to track the cost of the project during development and must interface with the organization's financial recording and reporting system [INCOSE, 2004]. It is important to take cost estimating seriously if a project is to be completed within budget constraints. Several types of cost estimates may be used for a project and will vary based on when they are done, how they are used, and how accurate they are. A rough order of magnitude (ROM) estimate is done very early in a project and provides a budgetary estimate of the project's cost. This estimate is used to allocate project funding; an action that typically occurs 1-2 years prior to project initiation. A definitive estimate provides the most accurate estimate of project costs. Although there are many tools and techniques to assist in creating more detailed cost estimates, past experience has shown that they are still likely to be very inaccurate, especially those involving new technologies or software development [Schwalbe, 2002]. Experience has shown, that early in the ITS project initiation stage where project feasibility is being determined, use of comparable systems costs is preferable. The key is to use a comparable system that has similar coverage and functions and to concentrate on "big ticket" items (e.g., communications, field hardware such as dynamic message signs, software, and operations personnel). Even if a comparable system on which to base a cost estimate is found, plan to include a contingency of 25 to 50%, perhaps more if there is a significant amount of new software development.

In terms of schedules, delivering an ITS project on time is typically one of the biggest challenges. Schedule development is part of a larger project time management process that includes:

- **Activity definition** involves identifying the specific activities that project team members and stakeholders must perform to produce the project deliverables. An activity or task is an element of work (normally found on a work breakdown structure (WBS)) that has an expected duration, cost, and resource requirements.

- **Activity sequencing** involves identifying and documenting the relationships between project activities.

- **Activity duration estimating** involves estimating the number of work periods that are needed to complete individual activities.

- **Schedule development** involves analyzing activity sequences, activity duration estimates, and resource requirements to create the project schedule.

- **Schedule control** involves controlling and managing changes to the project schedule.

Schedule development uses the results of all the preceding time management processes to determine the start and end date of the project. These processes usually require several iterations before the schedule can be finalized. The ultimate goal of schedule development is to create a realistic project schedule that provides the basis for monitoring project progress [Schwalbe, 2002]. Like cost estimation, there are number of tools and techniques to assist in the schedule development process. And as with cost estimation, experience has shown that use of a comparable system schedule is preferable along with the incorporation of a significant 25% to 50% contingency.

Other Considerations

Once an acceptable project scope has been established, it is necessary to consider other fundamental approaches to the system development. Two of the most important considerations to be included in this step are the need for the development of a unique system vs. the purchase of a COTS solution, and the possible use of outsourcing. Both of these procurement approaches were discussed in the Task 4 report. They are summarized here.

<u>Custom vs. Off-the-Shelf Solutions:</u> The functions performed by ITS systems, are rarely unique. In most cases, they are nearly identical to those of other systems that have been previously installed. For example, the typical freeway management performs a basic set of functions such as field device control (variable message signs, highway advisory radio, CCTV, ramp meters, etc.), data collection (traffic, weather, etc.), and incident management related functions**.** The relative low number of functions performed in a system of this type, and their commonality with the similar functions of other systems, suggests the use of software developed for previously installed systems. This is known as commercial off-the-shelf (COTS) software. If the use of COTS software is a possibility, it should be considered during the procurement phase of the system acquisition, since the contractor using the preferred COTS solutions should receive priority consideration as the system implementer. The use of COTS software offers a number of advantages over the development of unique software including the acquisition of a relatively mature (previously tested) package, the economic benefits of sharing the cost of upgrades with other agencies and the ability to acquire a package whose capabilities can be viewed prior to the initiation of system acquisition. However, if many new capabilities and interfaces are required, COTS software cannot necessarily be used. Even under these conditions, it is desirable to maximize the amount of mature previously tested software and hardware used in the new system.

Outsourcing: Outsourcing is the process by which organizations (public or private) use external providers to manage or maintain certain aspects of their business. Outsourcing is being increasingly used by the public sector in response to increasing citizen demands for service and the difficulty of competing with the private sector for specialized talent. For an ITS project, types of outsourcing include:

- Maintenance Outsourcing**:** System maintenance can all be performed by the agency, it can all be outsourced to a maintenance contractor, or a hybrid approach can be used in which some system elements are maintained by the agency and others by a contractor. Maintenance outsourcing typically includes field equipment (variable message signs, cameras, detectors, etc.), but may also include the central system (TMC hardware and software).

- Operations Outsourcing: While operations are outsourced less frequently than maintenance, this form of outsourcing is not uncommon. Operations services for running a transportation management center can be outsourced to a private firm. Through contracting, an agency places the complete staffing burden (recruiting, hiring, training and firing) on the private contractor.

- Performance Based Services: Contracts for performance based services are initiated by agencies that do not want to be involved with the implementation of a complex system or service, but would prefer to contract with an organization on the basis of the outcome that is provided rather than specifying the provision of a particular system or service. In other words, the agency is contracting for the provision of an end result, rather than purchasing a particular item. This purchase is defined in terms of the required performance.

PROCUREMENT PLANNING

Once the initial project planning has been completed, procurement planning can be initiated. See shaded section of Figure 2. As indicated in the figure, procurement planning includes a number of steps each of which is described in this section. Procurement planning also known as Acquisition planning identifies all the necessary and key decisions and actions that must be considered for a successful ITS acquisition and contract award. The procurement plan will allow coordination and the proper sequencing of actions throughout the contracting process. The complexity of a project can have a significant impact on the selection of a procurement strategy. ITS projects can range in complexity from those that are relatively straightforward as in adding field devices (e.g., CCTV, DMS, etc.) to an existing traffic management system, to those that are extremely complex such as the implementation of a new transportation management system that might include the implementation of a new central control facility and the deployment of field devices. The procurement strategy for these two undertakings would be significantly different.

However, a procurement strategy cannot be based solely on the complexity of the project. Equally critical to development of a successful procurement strategy are the agency's resources and capabilities as well as the environment in which the project will be planned, designed, deployed, and operated. Does the agency have personnel with prior ITS type project experience? Is the agency organized to successfully plan, design, implement, operate, and maintain an ITS type project? Is there management support for dedicating adequate resources throughout the ITS project's life cycle? What exactly are the expectations of agency management and can these expectations realistically be met? Answering these questions is an important part of developing a procurement strategy.

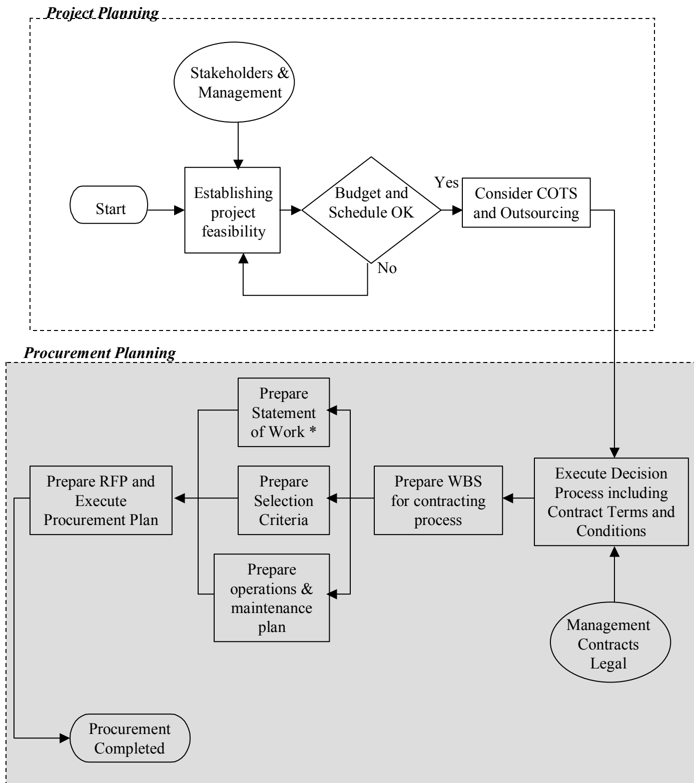
Another important consideration is whether or not a project should be implemented under more than one contract. Not all contracts associated with a project require the same contracting approach. The magnitude of a project may involve a mix of complexity and incompatible services (e.g. construction, custom software development, systems integration, operations and maintenance) that diminishes the possibility for implementation success under a single contractor. The key to an effective procurement strategy is to apply the appropriate procurement package(s) (work allocation, method of award, contract form, and contract type) based on the complexity and risk associated with the work being undertaken, the capabilities of the implementing agency, and the appropriate system development process. The decision model described in this report will facilitate the process of making an appropriate procurement package selection.

The Decision Model

The following considerations set the stage for the Decision Model, which is based on the two dimensions of system engineering process and agency experience/environment. More precise terminology will be defined later in the section.

- Systems engineering process has major influence on contracting approach.
- Agency experience/environment also has a major influence on the contracting approach.
- Project characteristics have a major influence on the contracting approach.
- Defining the process and agency permit selection of the appropriate contracting approach.
- In actuality, there are four basic contracting processes (defined as packages here). The other contracting dimensions are adjustments to these processes.
- Contract terms and conditions are an important element of the contracting process. They are defined once a package has been selected.

Figure 2. The Planning Process Highlighting Procurement Planning



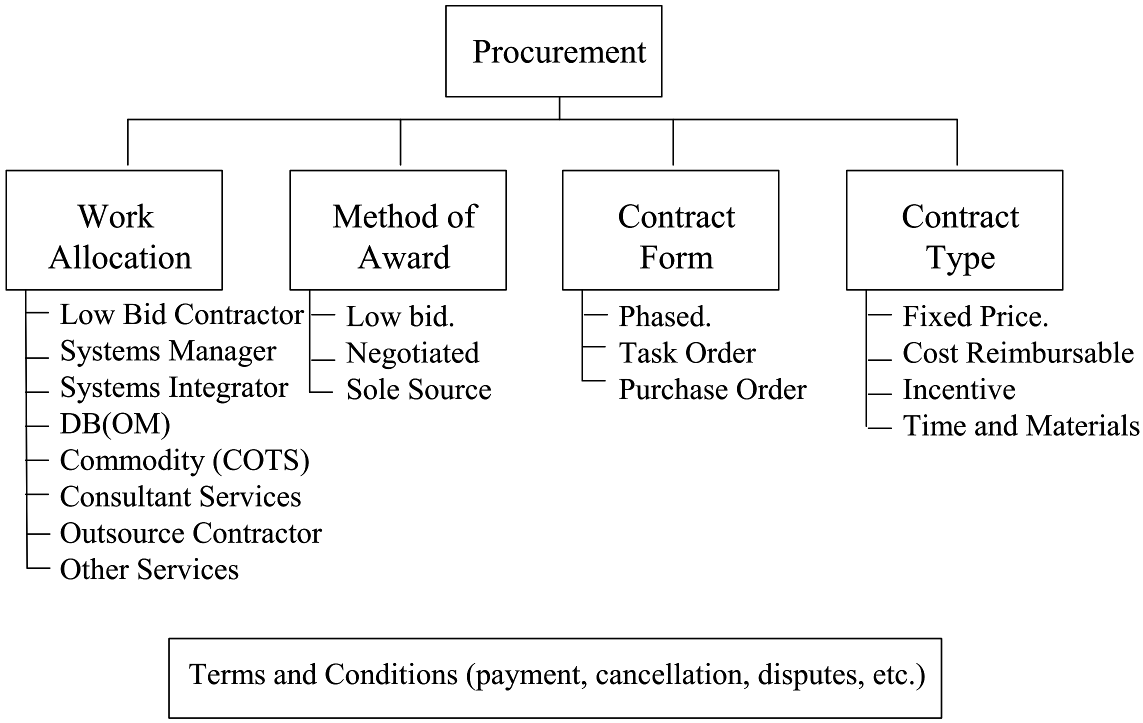
* May also include plans and specifications as required by the selected contracting alternative

The decision process presented here represents the results of multiple reviews both by the NCHRP review panel, as well as the testing of the process with five real-world systems.

The Basic Model (Structure and Packages): The four dimensions of procurement shown in Figure 3, along with the terms and conditions, provide a structured representation of the contracting process (procurement). The purpose of the selection procedure described in this section is to select the combination of items (one from each of the four dimensions) that are most appropriate for the project characteristics and the agency's capabilities.

Early in the development of this process, it was recognized that there are only a few combinations of these items that are practical. This led to the definition of work packages that include unique combinations of procurement characteristics, selected from each of the dimensions of Figure 3. Contract terms and conditions are not included in the procurement packages, but are selected as a separate step. These packages are based on the work allocation dimension of Figure 3, which is the fundamental variable that drives the entire process.

Figure 3. Four Dimensions of Procurement



The characteristics contained in each of the seven procurement packages (named to correspond with their associated work allocation), are shown in Table 1. The objective of the selection process is to identify the most appropriate procurement package for a given project. The package numbers shown in the table are referenced in the initial steps of the decision process. Generally, packages 1 through 4 are used for traditional system implementation, although they can obviously be used for other purposes. Package 5 is either a supporting function for the system implementation, or may be used for numerous other consultant activities. Packages 6 and 7 are used for the provision of activities (an internal agency process such as inspection, maintenance, operations, mowing, or signal timing) and functions (an entire agency service such as traffic management, traveler information or toll collection) in a manner that reduces the agencies staffing requirements. Packages have not been defined for the "other" category of the work allocation dimension.

It is possible to begin the selection process with the objective of choosing the most appropriate procurement package. This process is presented as a sequence of steps that must be followed to arrive at a conclusion, which in turn leads to the identification of the terms and conditions to be used with the selected package.

Table 1. Procurement Packages

Package No.	Work Allocation (Package Name)	Method of Award	Contract Form	Contract Type	Comments
1	Commodity Supplier	Low-bid selection of prequalified packages	Single phase or purchase order	Fixed Price	Used for COTS procurements
2	Low-Bid Contractor with Consultant Design	Low-bid for contractor	Phased orTask Order	Fixed Price for contractor incentives optional	Consultant performs 100% of design. May provide additional services during implementation
3	Systems Manager	Quality-based selection (negotiated procurement)	Phased or Task Order	Fixed price, cost plus or time & materials incentives optional	Field equipment procured by agency using low-bid process
4	Design-Build Contractor with Design Consultant	Best-value selection (based on consideration of price and quality)	Phased	Usually fixed price, cost plus or time & materials incentives optional	Consultant provides 30% design.
5	Consultant	Negotiated	Phased or Task Order	Fixed price, cost plus or time & materials incentives optional	Used for system design and many other consultant services
6	Outsourcing Agency Activity	Low-bid may be based on rates	Usually single phase	Fixed price or time & materials incentives optional	Typical activities include maintenance, operations, signal timing, etc.)
7	Outsourcing Agency Function	Best value or low-bid	Single phase	Fixed price, cost plus or time & material contracts Incentives optional	Typical functions include traveler information and toll collection. May be public-private partnership

Step 1

The first step in the decision process is to identify the fundamental project characteristics that differentiate between a system development, a consultant contract and an outsourcing contract. These differences were determined during the project planning activities described earlier. This logic is formalized in Figure 4, which leads directly to the identification of an appropriate procurement package or guides the user to the more complex steps required for system development. If a procurement package is directly selected, the user can then skip Steps 2 through 6 of the decision process and proceed to Step 7 (consultation with procurement officials).

The process that should be followed for the execution of the remainder of the decision process is shown in Figure 5. This process emphasizes the considerations associated with a system development. As indicated in Figure 4, contracting for services or outsourcing leads directly to the selection of procurement packages 5, 6 or 7, and the user can then skip to step 7 of the decision process shown in Figure 5.

Step 2

The second step (Step 2) in the process determines whether the acquisition should be performed as a single project or multiple projects. Step 2 is the bridge between figures 4 and 5. Figure 5 presents the relationship between the steps in the overall decision process. It is shown as one of the initial activities the decision model, since the model must individually consider each of the individual projects resulting from this decision. In other words, it is not necessary that each project be executed using the same contracting process. This is particularly true when the nature of the work in each contract is different. For example, one project may include the central system (including software) implementation, while another project might consist only of field installations.

Thus this step of the process allocates the total work associated with the project to individual contracts. It may very well be that only a single contract is required. However, even if all of the project work can be performed by a single contractor (i.e. none of the reasons listed below apply), there may be a need for supporting contractors who might be performing such tasks as general advisory support, site inspection, system design, website design, or independent validation and verification (IV&V) of the contractor's work. The reasons to consider multiple contracts for the mainstream project activities include:

- Significant amount of software and systems development, but largest dollar amount is in construction (i.e. systems contractor will not be prime unless separate contracts are issued for the systems contractor and the construction contractor)
- Uncertain of the likelihood of selecting a satisfactory prime contractor for the overall project (i.e. not putting all of "ones eggs in the same basket")
- "Political" requirement to spread the work around (this might be particularly true if the project involves a significant amount of field construction)

Figure 4. Initial Decisions – Step 1

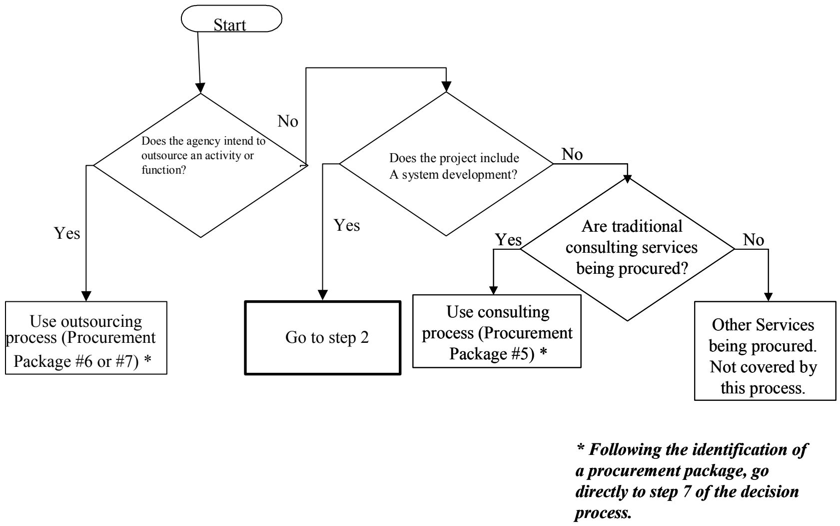
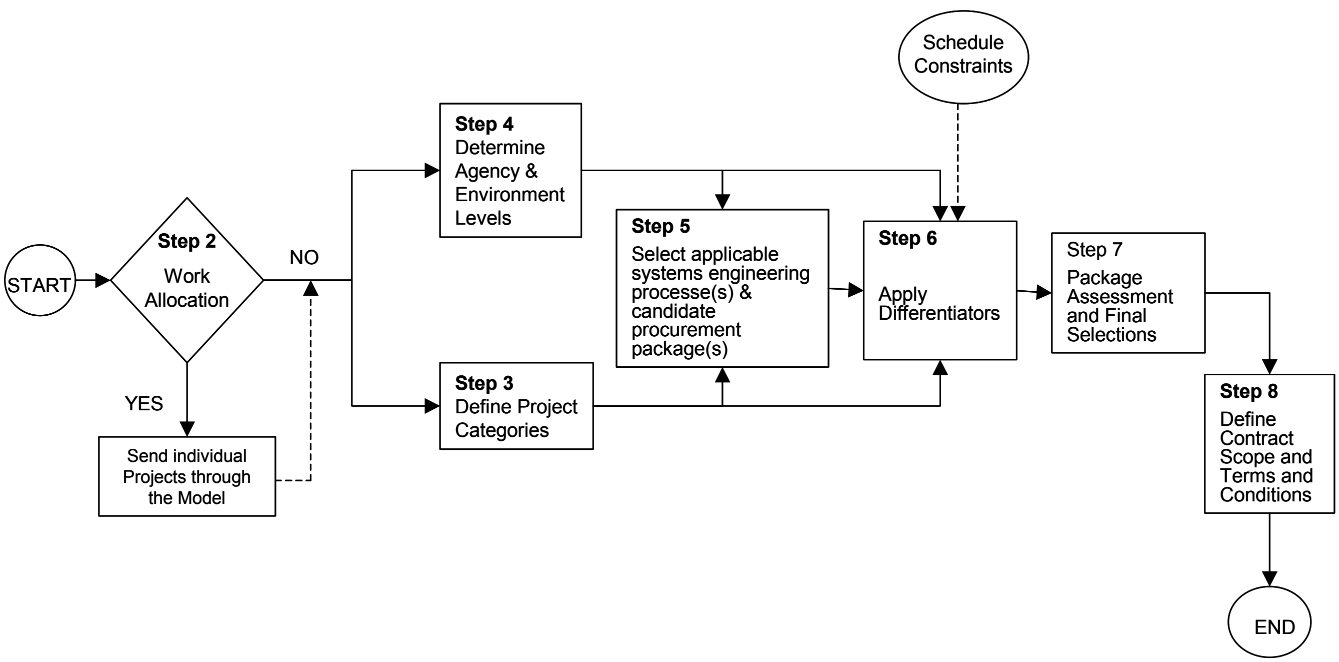


Figure 5. The Decision Model – Steps 2 Through 8



Unless there are compelling reasons to do otherwise, it is always best for all software and systems integration work to be contained in a single prime contract, to ensure a single point of responsibility and to minimize the complexities of managing multiple contractors. When multiple contracts are needed, it is important to minimize interdependency of contractors (i.e. where one contractor depends on another contractor's completion).

Step 3
The third step of the process (Step 3) is the definition of project categories. This step relies on the work performed during Task 3 of this NCHRP project (see Table 2) that identified categories of project difficulty using the characteristics of the work to be performed. During Step 3, Table 2 is used to determine whether the project is a Category 1, 2, 3 or 4 project. This step and all subsequent steps must be executed for each of the projects defined during Step 2.

Step 4
The fourth step involves a determination of the agency's capability level. This step uses the information in Table 3 to determine the level that best suits the agency managing the system acquisition. In essence, this step is used to assess the agency's organization, experiences and resources relative to ITS procurements.

Step 5
Step 5 is one of the key steps of the process in that it is used to identify the appropriate contracting and systems engineering processes for the project being initiated.

To execute this step, it is important to understand the alternative systems engineering processes that were described in the Task 4 report of this NCHRP project. The alternative processes (also known as models) were described, the Waterfall Model, the Evolutionary Model, and the Spiral Model.

The Waterfall Model is representative of highway design and construction processes in which steps of planning, designing, and implementing are performed sequentially. This model is used for less complex ITS projects and can be applied under all Organizational Levels.

The Evolutionary Model defines a sequence of phased planning, requirements, design, and implementation stages resulting in the deployment of phased versions of a system such that each version is closer to the ultimate system vision. It is best used for complex ITS projects involving new development, wide array of technology, multiple interfaces with other systems, and lack of clearly defined requirements. It should be used by all organizational levels for most system developments. Because the evolutionary model divides the system development into relatively simple implementation stages, it will contribute to the successful development of complex new systems.

Table 2. ITS Project Categories and Associated Characteristics

Complexity	Category 1 Straightforward	Category 2 Moderately Complex	Category 3 Complex	Category 4 Extremely Complex
Level of New Development	Little to no new software development / exclusively COTS software and hardware based or based on existing proven software and hardware.	Primarily COTS software / hardware or existing software / hardware based with some new software development or new functionality added to existing software - evolutionary development.	New software development for new system, replacement system, or major system expansion including use of COTS software. Implementation of new COTS hardware.	Revolutionary development - entirely new software development including integration with COTS or existing legacy system software. Implementation of new COTS hardware or even prototype hardware.
Scope & Breadth of Technologies	Application of proven, well-known, and commercially available technology. Small scope in terms of technology implementation (e.g., only CCTV or DMS system). Typically implemented under a single stand-alone project, which may or may not be part of a larger multi-phased implementation effort.	Primarily application of proven, well-known, and commercially available technology. May include non-traditional use of existing technology(ies). Moderate scope in terms of technology implementation (e.g., multiple technologies implemented, but typically no more than 2 or 3). May be single stand-alone project, or may be part of multi-phased implementation effort.	Application of new software / hardware along with some implementation of cutting edge software, hardware, or communication technology. Wide scope in terms of technologies to be implemented. Projects are implemented in multiple phases (which may be category 1 or 2 projects).	New software development combined with new hardware configurations/components, use of cutting edge hardware and/or communications technology. Very broad scope of technologies to be implemented. Projects are implemented in multiple phases (phases may be category 1 or 2 projects).
Interfaces to Other Systems	Single system or small expansion of existing system deployment. No interfaces to external systems or system interfaces are well known (duplication of existing interfaces).	System implementation includes one or two major subsystems. May involve significant expansion of existing system. System interfaces are well known and based primarily on duplicating existing interfaces.	System implementation includes three or more major subsystems. System interfaces are largely well know but includes one or more interfaces to new existing systems / databases.	System implementation includes three or more major subsystems. System requires two or more interfaces to new and/or existing internal/external systems and plans for interfaces to "future" systems.
Technology Evolution	Need to account for technology evolution perceived as minor. Example would be to deploy hardware and software that is entirely compatible with an existing COTS-based system. Ramifications of not paying particular attention to standards considered minor. System implemented expected to have moderate to long useful life.	Need to account for technology evolution perceived as an issue to address. Example includes desire for interoperable hardware from multiple vendors. Ramifications of not paying particular attention to standards may be an issue, as an agency may get "locked-in" to a proprietary solution. Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have moderate to long life.	Need to account for technology evolution perceived as a significant issue. Examples might include implementation of software that can accommodate new hardware with minimal to no modification and interoperable hardware. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.	Need to account for technology evolution perceived as major issue. Examples include software that can easily accommodate new functionality and/or changes in hardware and hardware that can be easily expanded (e.g. add peripherals), maintained, and are interoperable. Ramifications of not using standards based technology are considerable (costs for upgrades, new functions, etc.) Field devices expected to have moderate to long useful life. Center hardware life expectancy is short to moderate. Control software is expected to have an extendable useful life.
Requirements Fluidity	System requirements are very well defined, understood, and unlikely to change over time. Formal requirements management a good idea, but not a necessity.	System requirements are largely well defined and understood. Addition of new system functionality may require more attention to requirements management.	New system functionality includes a mix of well defined, somewhat defined, and fuzzy requirements. System implementation requires adherence to formal requirements management processes.	System requirements not well defined, understood, and very likely to change over time. Requires strict adherence to formal requirements management processes.
Institutional Issues	Minimal- project implementation involves one agency and is typically internal to a particular department within the agency.	Minor- may involve coordination between two agencies. Formal agreements not necessarily required, but if so, agreements are already in place.	Significant- involves coordination among multiple agencies and/or multiple departments within an agency or amongst agencies. Formal agreements for implementing project may be required.	Major- involves coordination among multiple agencies, departments, and disciplines. Requires new formal agreements. May require new multi-agency project oversight organization.
Overall Risk	LOW	MODERATE	HIGH	VERY HIGH

Table 3. Agencies Capability Levels as a Function of Characteristics

	Level 1	Level 2	Level 3
Personnel Experience	ITS assigned as part-time job to person with no staff and little to no specific ITS experience.	ITS assigned as full-time job with no staff or some part-time staff support. Person assigned has some specific ITS experience with Category 2 or 3 projects. Staff support (if it exists) has little to no ITS experience.	Full-time ITS Manager and staff with significant prior ITS experience. Staff support includes system administration, operations, and maintenance responsibilities.
Organizational Experience	Little to no experience with the possible exception of Category 1 ITS projects.	Experience with at least one Category 2 or greater project.	Experience with at least one Category 3 or greater project.
Organizational Structure	ITS responsibility not defined. Responsibility housed within organization with other mission or primary responsibility. Responsibility may also be scattered amongst organizational entities with no clear lines of responsibility.	ITS responsibility somewhat, but not adequately defined. Individual organizational units have ITS responsibility and have their own budgets, management, and priorities; however, there is no definitive linkage between these units. An umbrella ITS organizational unit may exist, but may not have the budgetary authority to effectively manage sub-units.	Established organizational unit with budgetary authority and clear ITS responsibilities. Organizational unit ties all ITS responsibilities together and includes a procurement process that supports ITS acquisition (e.g., personnel, policies, and procedures).
Resources	Little to none. No identifiable ITS budget categories or identification of specific ITS funding within existing organizational units.	Some budget resources (e.g., ITS earmark funding) assigned to one or more existing organizational unit(s). Support for personnel, equipment, office space, and training expected to come from organizational unit(s) existing budget.	Identifiable budget category set aside for ITS. Budget includes support for all required personnel, support equipment, office space, training, and (if necessary) consulting support.
Management Support	Some mid-level management support for ITS/Operations, but little to no interest at top management levels. ITS/Operations not recognized as an agency priority.	Strong mid-level management support for ITS/Operations with some interest/involvement at top management levels.	Top level management support. ITS/Operations considered an agency priority within its overall mission.
Expectations	Not defined or limited to a lower category ITS project that's under consideration for deployment, expansion, or replacement.	Expectations exist for a few "special" ITS related project. Expectations may or may not be realistic depending on if they've been managed properly.	ITS/Operations is part of both short and long range planning. Expectations are well defined with actual performance measures. ITS/Operations expectations focus on improvement and not on "status-quo."

The Spiral Model is only appropriate for the development of new applications requiring a lot of planning, prototyping and evaluation. This model is rarely used by the ITS community, since its application is expensive and time consuming. It is most commonly used by the Department of Defense and NASA for the development of new weapons systems, or space platforms. It is found in the ITS community in such advanced developments as the automated highway system and some of the new in-vehicle safety systems. To use the Spiral Model, a Level 3 organization with an experienced full time ITS manager and staff is recommended. The spiral methodology involves lots of prototyping and feedback requiring significant agency staff time. A Level 2 organization, with significant consultant resource support (assuming this can be obtained), could oversee this development model but at greater risk for failure. A Level 1 organization would not have the experience, structure, or resources to appropriately manage and be involved in this development process (see Table 4).

Table 4. Relationship Between System Development Process, Organization Level and Project Category

Organizational Level	Project Category	System Development Process
1	1	Waterfall
1	2	Evolutionary
1	3	Not recommended
1	4	Not recommended
2	1	Waterfall
2	2	Waterfall or Evolutionary
2	3	Evolutionary
2	4	Evolutionary or Spiral
3	1	Waterfall
3	2	Waterfall or Evolutionary
3	3	Evolutionary or Spiral
3	4	Evolutionary or Spiral

With an understanding of the relationship between systems engineering processes, project categories and agency levels, along with the characteristics of the various procurement packages, it is now possible to execute Step 5. The decision matrix shown in Table 5 is used as the basis for this step. To use this matrix, it is necessary for the agency to have identified its project category, and its organizational level of capability. The agency then identifies the columns and rows of the matrix that match this combination of capabilities and levels. The intersection of the applicable column and row identifies the cell that defines the procurement package or packages that should be used.

The COTS entries reflect the fact that a simple system, based entirely on a COTS product should be acquired using the commodity procurement package. When COTS products are part of a larger system, other procurement packages may be used (i.e. the product may be part of a proposal for low-bid, systems manager, or design-build procurements). A design-build contractor or a systems manager may decide to acquire a COTS product during the system implementation. If this is the case, the product should be acquired by the contractor using a commodity procurement package.

Many of the cells in the matrix provide the user with the flexibility to choose between multiple packages and systems engineering techniques. Step 6, discussed next, is used to provide additional differentiation between multiple solutions. If a cell indicates that the project is "Not recommended", the agency should either seek more experienced staff support or redefine and simplify the project. At this point, no amount of optimism can be used to overcome fundamental shortcomings in experience or resources.

Table 5. The Decision Matrix – Step 5

Project Category	*Agency Capability Level*		
	Level 1	*Level 2*	*Level 3*
1 – Low	• ***Waterfall*** • SM*	• ***Waterfall*** • Low Bid*, commodity, or SM	• ***Waterfall*** • Low Bid, commodity, or SM
2 – Moderately Complex	• ***Evolutionary*** • SM or DB*	• ***Waterfall or evolutionary*** • Low Bid*, SM or DB	• ***Waterfall or evolutionary*** • Low Bid, SM or DB
3 – Complex	***Not recommended***	• ***Evolutionary*** • SM or DB	• ***Evolutionary or spiral*** • SM or DB
4 – Extremely Complex	***Not recommended***	• ***Evolutionary or spiral*** • SM or DB	• ***Evolutionary or spiral*** • SM or DB

Notes:

First line is the systems engineering technique; second line is the procurement package
DB = Design Build
SM = Systems Manager
* - Consulting services should be used while project is underway

Step 6

The next step in the process, Step 6, is to be used when more than one procurement package type is identified as acceptable during Step 5. It provides some additional criteria to help reduce the number of alternatives. These criteria are listed below:

- Systems manager is preferred to design-build when significant amount of new software development required.
- Design-build is preferred over systems manager only for major projects when significant amounts of field construction are involved and there is a desire to reduce implementation delays associated with having to administer multiple procurement contracts.

- The evolutionary systems engineering model is preferred over the spiral model because it is less costly and easier to apply. The spiral model should only be used in the event that complex new developments are required.

- If a project includes both new software and field construction, consider splitting it into multiple contracts.

- Low-bid contracting should only be used if:
  - Required by agency policy, and/or
  - Projects are limited to field construction and supply of off-the-shelf equipment.

- Commodity procurement is only applicable if an existing package is available that does not require any modification to meet agency's requirements except for:
  - New drivers for interface with communications and field equipment,
  - New database reflecting system configuration, and
  - New map graphics.

If after considering these differentiators, multiple solutions still remain, the preferred alternative should be chosen based on the preferences of the agency's procurement officials (See Step 7).

Next, as with Step 1, it may be necessary to assess the need for consulting assistance and/or provision of field construction and field equipment supply. The first time (Step 1) it was executed based on overall considerations of the extent and type of work to be performed. The second time this work is performed, it takes into account the requirements of the contracting package(s) selected during Steps 5 and 6. There are a number of requirements associated with each of the contracting packages that must be reviewed at this point of the procurement definition process:

- Design consultant must prepare the 100% design and a package of plans, specifications and estimates (PS&E) to be used during the low-bid process. Thus two contracts will be required; one for the design consultant and a second for the low-bid implementation contractor.

- Systems manager contractor is, in effect a consultant. For this reason, major items of field construction and the furnishing of field equipment must be performed by contractors selected on a low-bid basis. Thus two or more contracts will be required; one for the systems manager and additional contracts for construction, electrical contracting and equipment supply. These additional contracts will all be low-bid. All of this work (construction, electrical contracting and equipment supply) may be combined into a single contract for field device implementation.

- Design consultant must prepare a 30% design to be used for the selection and negotiations with a design-build contractor. Thus two contracts are required; one for the design consultant and a second for the design-build contractor. Note that some agencies with significant ITS expertise and design personnel on staff (Level 3) could prepare 30% design plans in-house.

- Commodity procurements often require the services of a systems integrator, systems manager or design-build contractor to implement the COTS product being acquired.

Step 7
Step 7 is a critical step for all procurements. If it has not been done already, at this point it is imperative to discuss decisions made to this point with agency procurement personnel. It may also be desirable to include legal personnel to discuss intellectual property rights, which must be considered during the preparation of terms and conditions in Step 7.

In the event that multiple procurement alternatives exist at the conclusion of Step 6, the final selection of the preferred alternative must be made cooperatively with procurement staff. This decision must consider agency policies, and should possibly give preference to alternatives with which the agency has had prior experience. Prior experience is not necessarily limited to agency experience with highway construction, but should include experience with other procurement activities such as procurement of data processing hardware and software.

Step 8
The final step in the decision process is the selection of the necessary terms and conditions to be included in the contract. Some terms and conditions are required for all types of contracts. Others are only suitable for certain types of contracts (i.e., commodity supplier, low bid with design consultant, system manager, and design-build contractor). Table 6 lists the mandatory contract terms and conditions that should be considered regardless of procurement package used. Table 7 identifies terms and conditions that are most appropriate to a specific procurement package.

Work Breakdown Structure (WBS)

Following the selection of a contracting approach along with its associated terms and conditions, it is possible to continue the contract planning activities identified in Figure 2. The first activity in this process is the development of a work breakdown structure (WBS) for the procurement process.

Table 6. List of Mandatory Contract Terms and Conditions

Parties to the Contract	Delays and Extensions of Time
Scope of the Contract	Modifications
Compensation and Method of Payment	Multiple Contract Awards
Extras	Liquidated Damages
Assignment of Claims	Variations in Estimated Quantities
Agency Furnished Property	Suspension of Work
Order of Precedence	Incorporation by Reference
Commercial Warranty	Specifications
Patent Rights	Delivery and Acceptance
Multiyear Contracts Contingent upon Appropriations	Intellectual Property
Termination for Default	Contractor's invoices
Termination for Convenience	Conflicting Terms

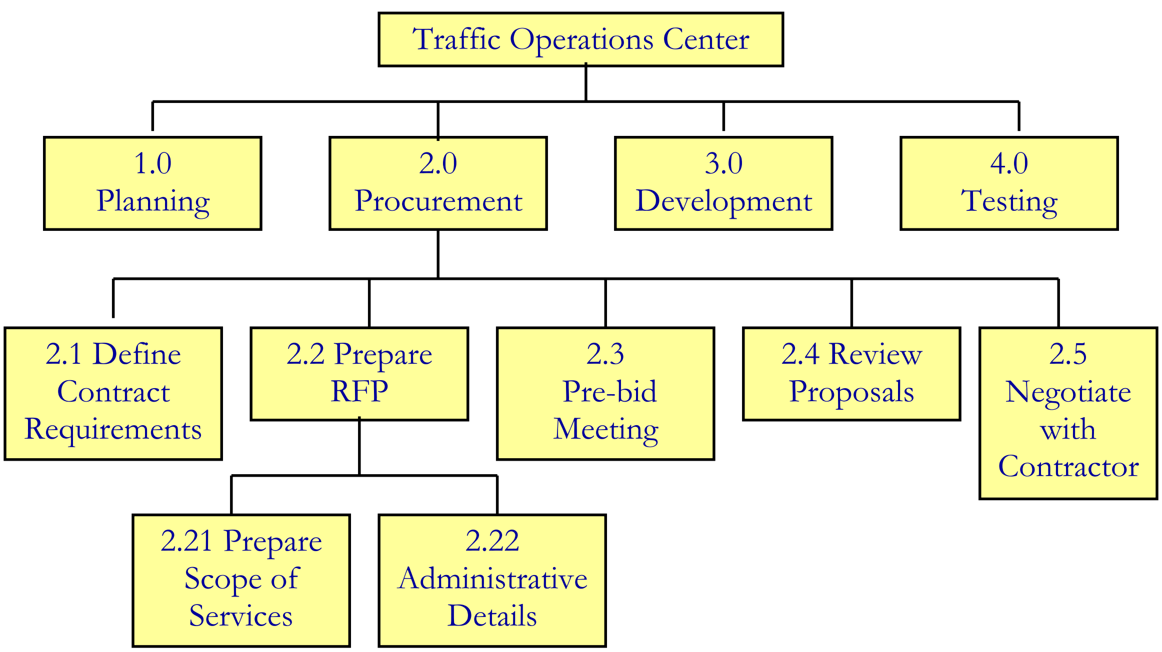
Table 7. Procurement Packages and Their Associated Terms and Conditions

Commodity Supplier Terms and Conditions	Low-Bid Contractor with Design Consultant	Systems Manager	Design-Build Contractor with Design Consultant
Contractor Inspection Requirements	Design within Funding Limitation	Negotiation	Negotiation
Inspection of Supplies	Redesign Responsibility for Design Errors or Deficiencies	Commercial Computer Software Restricted	Design within Funding Limitations
Option for Increased Quantity	Deficiencies	Rights	Redesign Responsibility for Design Errors
Ordering	Fixed Price	Fixed Fee	Work Oversight
Definite Quantity	Incentive Fee	Incentive Fee	Suspension of Work
Indefinite Quantity		Rights in Data	Fixed Fee
Brand Name of Equal		Allowable Costs and Payment	Incentive Fee
		Performance Based Payments	Execution and Commencement of Work
		Delivery Orders (task orders)	Performance/Payment Bond
		Specifications	Specifications and Drawings
		Delays and Extensions of Time	
		Modifications	
		Delivery and Acceptance	
		Conflicting Terms	
		Patent Infringement Indemnification	
		Federal grant Flow down Provisions	

A WBS is a component or deliverable-oriented view of the work that is frequently developed for the purpose of managing the project. However, a WBS should also be prepared for the agency managing the system acquisition (including the procurement process), to define its activities and outputs and to serve as the basis for developing a schedule for the procurement. This level of planning is rarely executed by public agencies, with the result that procurement schedules slip, and contractors are prevented from planning the proposals and cost estimates associated with the procurement process. The availability of a WBS and its associated schedule permits scheduling meetings (both internal – including stakeholder meetings) and external with contractors as required by the selected procurement alternative.

A work breakdown structure (WBS) is a hierarchical breakdown of the work necessary to complete a project. The purpose of a WBS is to divide a project into manageable components, each which have identifiable outputs. Use of WBS is common for a private sector contractor implementing an ITS project. However, its application by the public sector to ensure proper involvement in project implementation is less common. Figure 6 identifies a WBS for a public sector agency involved in implementation of a traffic operations center. This figure emphasizes the WBS for procurement. Each activity associated with the procurement is identified.

Figure 6. Typical Work Breakdown Structure for Traffic Operations Center Procurement

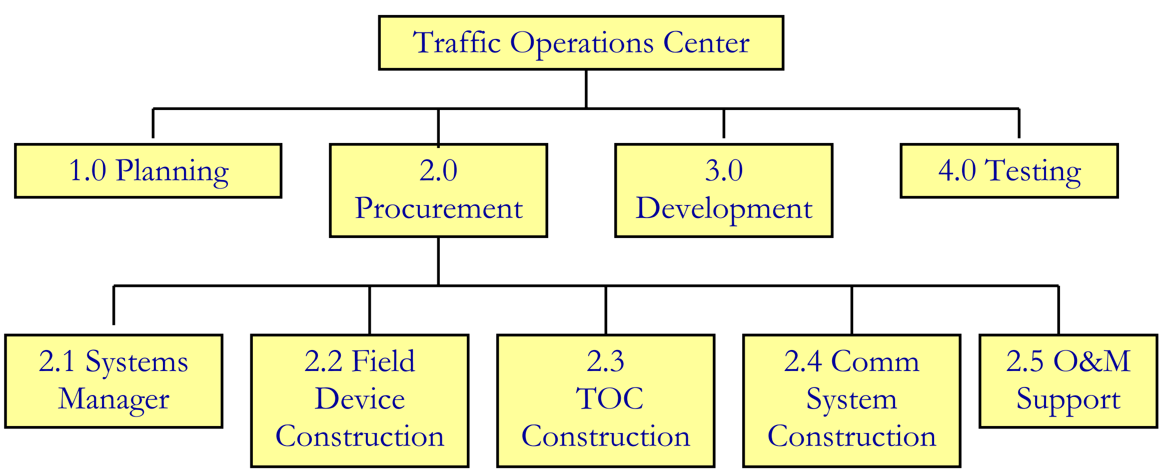


Projects of significant complexity (e.g., Category 3 – 4) may involve using multiple contracts to plan, design, build, integrate, operate and maintain a complete system. A work breakdown structure specifically addressing procurement can ensure that appropriate contracts are put in place in accordance with the overall implementation schedule.

Figure 7 shows the multiple contracts as activities 2.1 through 2.5. Note that activity 2.5 defines an activity for ongoing support after the project has been completed. If a separate competitive procurement is to occur at this point, it will be necessary to plan the procurement associated with this activity. Although not specifically shown in this figure, there is an additional, more detailed row of activities under activities 2.1 through 2.5. For example, the activities under 2.1 might include:

2.1.1 Stakeholder meeting to identify overall project goals, and project phases
2.1.2 Define contract requirements
2.1.3 Prepare contract statement of work
2.1.4 Define intellectual property rights
2.1.5 Prepare evaluation plan
2.1.6 Prepare RFP
2.1.7 Select proposal evaluation committee
2.1.8 Disseminate draft RFP for review and comment
2.1.9 Prepare final version of the RFP
2.1.10 Issue request for proposals
2.1.11 Receive and evaluate proposals
2.1.12 Evaluation committee reviews proposals and selects preferred contractor
2.1.13 Selection reviewed by procurement
2.1.14 Negotiations with preferred contractor
2.1.15 Contract award

Figure 7. WBS for Procurement – Multiple Contracts



The sequence in which each of these items occurs should be defined, as well as its schedule, inputs, outputs, and the responsible party. This process should be repeated for activities 2.2 through 2.5 as well. This process is essential for multiple contracts in which the activities of one contractor are dependent on the successful completion of others.

Once the WBS has been prepared and a procurement schedule developed, it is possible to begin developing its component parts including the statement of work (also known as the scope of services, the evaluation plan (contractor selection process), and a plan for operations support both during and after the project acquisition. The issue of intellectual property rights should be addressed during the preparation of the statement of work to ensure that the agency's position and policies on this subject are defined in the RFP.

Contract Statement of Work

The Statement of Work (SOW) is the most critical part of the acquisition process in that this above all else is the part of the document that describes the functions and/or services required. The SOW also defines what is to be delivered or accomplished by the contractor. A well-written SOW will allow for measuring the contractor's performance after contract award. Providing an excellent description of needs is important and is an area where purchasing or procurement personnel can assist departmental technical staff. Clarity and precise description of the requirement can reduce problems and improve the responses received from the offerors. Clearly defined requirements also provide for effective evaluation criteria avoiding delays and saving administrative effort.

The contents of the statement of work vary greatly depending on the type of project. They may include system plans and specifications (essential for a low-bid procurement), they may include a definition of software requirements (typically used for a system integrator project) or they may be restricted to a description of the process to be followed for the system development.

The following paragraphs define activities that should be included in the procurement of all ITS systems. They are highlighted here, because they are not used in all civil engineering projects.

Defining Deliverables: In the contract statement of work (SOW), it is important to list specific deliverables, describe them in detail, and specify when they are due. The number of specific deliverables will vary based on the scope and complexity of the project, but generally fall into the following categories:

- *System planning and design:* The contractor may be responsible for leading some or all of the activities associated with the system definition. These activities include preparation of the system concept of operations, definition of requirements, and/or the system design. System planning and design should always be performed with the participation of the agency personnel.

- *Written documentation*: Project management plans, system design documents (requirements, software development plans, software design documents, network diagrams, etc.), test plans, test results, maintenance plans, operations plans, warranty documentation, etc. If written documentation is to be provided in electronic format such as on a CD, this should be specified.

- *Hardware*: In general, it is more appropriate to require delivery of hardware such as computers and related peripherals based on system requirements such as, for example, reliability, storage, functionality, and performance as opposed to specific computer hardware. This may not be the case when specific field equipment hardware is being added to an existing system.

- *Software*: Defining software related deliverables could be challenging especially if a project involves custom software development. This typically is the result of software licensing and ownership issues which, if not defined properly, can lead to significant conflicts between the customer and contractor. Even the meaning of the word "software" in the contract language has been a frequent point of contention between customers and software contractors. Often, the customer interpreted "software" to include the source code, whereas the contractor meant for "software" to apply only to executable or object code.[1] This issue of software ownership falls within the realm of intellectual property (IP) rights. To avoid problems with IP, it is important that required software deliverables explicitly call out what rights the customer and contractor has to the software. [Note: Reference the Contract Terms and Conditions on negotiating intellectual property rights]

Defining Configuration Management Process: Configuration management is a "process for establishing and maintaining consistency of a product's performance, functional and physical attributes with its requirements, design, and operational information throughout its life. It is a process that ensures that the system performs as intended and is documented to a level of detail sufficient to meet needs for operation, maintenance, repair and replacement. "[2] Implicit in this description is the fact that configuration management applies to the entire system life cycle beginning with its planning and continuing through operations and maintenance. This definition also defines the need for consistency between requirements, design and operation. The relationship between requirements, specifications, hardware and software modules, and tests is maintained in a database known as a traceability matrix, which is used to define their associations. This often-overlooked aspect of system implementation is an essential element of the systems engineering process.

Defining the Validation and Verification: Validation and verification includes unit tests, factory tests, software module tests, acceptance pre-testing, and acceptance testing for both software and hardware The SOW must define all of the contractor's responsibilities for testing and testing support (validation and verification) during the system implementation. Validation and verification are processes for ensuring that the

[1] The Road to Successful ITS Software Acquisition, FHWA Publication No. FHWA-JPO-98-036
[2] ANSI/EIA 649 1998, National Consensus for Configuration Management 8-55

correct system was built (validation), and that the system was built correctly (verification). Validation occurs at the end of each evolutionary development phase, at which time the system is subjected to actual operational use by its operators and stakeholders. At this time, fundamental design shortcomings (e.g. the system does not adequately serve the organization's business processes) in the system concept may be identified and corrected during subsequent development phases.

Verification is the process of testing the system as it is being developed (unit and subsystem testing). It is also the process of formal acceptance testing of the fully assembled system. Acceptance testing is generally performed at the conclusion of each development phase. Acceptance tests are based on the system requirements using the information contained in the traceability matrix, and must be passed before the agency begins using the system under operational conditions. Acceptance tests must generally be passed prior to final reimbursement of the contractor for work performed on a given development phase.

Requirements for Reporting Metrics: The SOW must define the metrics to be collected and reported by the contractor. This requirements should also define the frequency with which these metrics will be reported and the manner in which they will be used. Metrics are measures used to judge the system development progress. Target objectives are generally defined prior to the beginning of development that can be used as the basis for comparison for concluding that development is proceeding in a satisfactory manner. Metrics may also be used as the basis for reimbursing the contractor for partially completed products. Typical metrics might include deliverables (documentation, completed subsystems, installed field equipment, etc.). They might also include comparison of schedule milestones with actual work accomplished. Other metrics include number of requirements defined, number of fully tested software modules, length of communications conduit installed or any other measurement that is an accurate representation of development status. Metrics are tools used to support both systems engineering and project management activities.

Defining the Risk Management Process: The SOW must require the contractor to manage the risk management process. This process must be designed to include both contractor and agency personnel. Risk management is the process of identifying potential problems before they occur, planning for their occurrence and monitoring the system development so that early actions can be taken. A typical ITS project potentially experiences many risks from technology, people and management. Representative risks include inadequate products, insufficient funding, staff turnover, delayed deliveries, incorrect schedule and budget estimates, etc. Risk planning must be a collaborate process between the contractor and the agency. A risk management plan must include a definition of the risk; its potential impact on the project if it occurs, and the mediation measures that will be taken to alleviate its impact. The plan must also include the metrics (measures) that will be used for early identification of the risk's occurrence.

Requiring Reporting of Schedule and Budget: Cost and schedule control is an important part of any project and requiring a contractor to provide regular reports of schedule and budget is an important part of the SOW. Reporting that is based on techniques such as earned value management (EVM) that integrates scope, time, and cost data can serve as a powerful management tool. Using a cost performance baseline, contract project managers can determine how well a project is meeting scope, time, and cost goals by comparing actual project progress against the baseline. Project management software is available that can greatly facilitate the cost management process and reporting. [Schwalbe, 2002]

Requiring Management of the Configuration Control Board: It is not unusual to include in the scope of work a requirement for the contractor to manage a Configuration Control Board (CCB). The CCB is an important element of configuration management with responsibility to ensure that management procedures are implemented to control the rate of scope and schedule creep. All of the key participants in the system development must be represented on the CCB. Typically, they include the agency's project manager, the contractor's project manager, systems engineering personnel, configuration management personnel, a manager with the authority to commit funding to the project, and other stakeholder representatives and specialists as required by the subjects being discussed. All changes to the system including new requirements, design changes, value engineering changes, bug fixes etc. must be formally approved by the CCB before they are implemented.

Ongoing System Support: The SOW must define the ongoing support to be provided by the contractor during system development, installation, acceptance testing, warrantee period, and full system operation. Ongoing system support or system maintenance refers to a series of methodical, ongoing activities designed to minimize the occurrence of systemic failures and to mitigate their impacts when failures do occur. These activities include replacing worn components, installing updated hardware and software, tuning the systems, and anticipating and correcting potential problems and deficiencies. Maintenance includes the development and implementation of action plans for responding quickly, efficiently, and orderly to systemic failures. It also includes an infrastructure and procedures for measuring and monitoring maintenance activities[3].

Contractor Selection Process

The method of award category of contracting defines the criteria used and steps taken to select a contractor to perform the work. The form of work allocation that has been selected determines the method of award. As indicated below, there are distinct differences between the various methods of award. These differences should be taken into account when selecting a form of work allocation.

- **Low-bid:** Low-bid contracting, commonly referred to as sealed bidding, is a contracting method the employs competitive bids, public openings of bids and low price awards. This contracting method must describe the agency's requirements clearly, accurately and completely. Award of the contract is made

[3] Guidelines for Transportation Management Systems Maintenance Concept and Plans, FHWA Report No. FHWA-OP-04-011.

to the responsive and responsible bidder, whose bid is most advantageous to the agency, considering only price and the price-related factors.

- **Negotiation:** Unlike formal advertising of a contract requirement, which is a precise, highly structured method of procurement with one definitive set of procedures, negotiation allows considerable flexibility, permitting the use of a number of different procedures in making awards. Negotiation differs considerably from low-bid procurement. First, proposals are not available for public inspection prior to award. Second, the agency is not required to reject proposals that vary from the Request for Proposals (RFP) requirements but may consider such proposals. Third, the negotiations permit discussions between the parties and modifications of proposals by offerors while low-bid does not. Finally, under negotiation, the procuring agency's source selection officials have a much greater discretion in selecting the successful offeror for award.

- **Sole Source:** Sole source procurement is the direct selection of a contractor without competition. Although this form of contractor selection is discouraged and may be illegal, there are some cases for which it is appropriate such as where unique services are required that can only be provided by a specific contractor or where specific field equipment is required to maintain compatibility with existing equipment and control software.

Considerations associated with the contractor selection process include prequalification and pre-proposal conferences for all contracts, and proposal evaluation for negotiated type contracts.

Pre-Proposal Conferences: Pre-proposal conferences can be used as a way to improve the quality of proposals received in response to an RFP. If a pre-proposal conference is held, it is important to include the date, time, and location in the RFP. A typical agenda for a pre-proposal conference includes a summary of the RFP by the customer with specific emphasis on key requirements and proposal evaluation criteria followed by an open question and answer session for the contractors. Contractors are frequently reluctant to ask any questions that will reveal their proposal strategy, so this segment of the meeting will typically be related to the mechanics of proposal preparation and delivery.

A good practice is to have each participating contractor complete a sign-in sheet with contact information. Copies of the sign-in sheet can then be made available for contractors interested in teaming opportunities. This is particularly important if the request for proposal requires the participation of firms with specific capabilities including disadvantaged businesses.

Contractor Qualifications and Certifications: Many projects require offerors (bidders or proposers) to demonstrate that they are qualified to perform work on a planned project before their proposals (or bids) are evaluated. Traditionally, this prequalification activity includes demonstrations of financial capacity to perform the work, or evidence that similar projects have been successfully completed and demonstration of their personnel or other resources availability for the project. In the past, this form of prequalification has proved to be of little value to the development of software-based systems because of the difficulty of defining “similar projects” and “successful completion”. As a result, the prequalification frequently leads to protests by firms that have failed to qualify for a project, sometimes with disastrous consequences. A solution to this problem is the use of a prequalification that demonstrates the knowledge and ability of potential bidders to implement the full systems engineering and development process. This demonstration of systems engineering and development capabilities can be established by requiring the contractor’s verification that its processes have been verified by an accredited organization. The appropriate certification for software development is known as the Capability Maturity Model (CMM)[4]. ITS projects involving the development and delivery of products (such as toll collection systems involving the production of large numbers of toll tags) might consider using the ISO 9001[5] certification in addition to CMM certification. ISO 9000 provides similar verification of the processes in use by potential offerors, but emphasizes equipment development, delivery and installation.

Proposal and/or Bid Evaluation: Conducting the proposal / bid evaluation will largely depend on the method of award. For example, for construction or off-the-shelf supply type projects, an agency will typically evaluate sealed-bids and make a selection based on the contractor that has the lowest price based on the specifications (and design plans). When obtaining services such as, for example, system manager services, an RFP is used and proposals are typically based on a combination of both technical merit and price. There are a number of methods and variations thereof used to evaluate technical and price proposals to come up with a final selection. In some cases, technical proposals are evaluated using scores based on specific criterion that may or may not be weighted. In other cases, a more qualitative method may be used to evaluate technical proposals by assigning adjectival ratings and supporting narrative to specific proposal criterion. The final selection may be based on the lowest cost of all technically qualified proposals, a formula that includes technical and cost proposal scores, and even best-value approaches that allow selection of a higher cost proposal based on superior technical merit.

The importance of understanding the process cannot be under estimated otherwise serious problems will be encountered including schedule slippage; confusion as to the roles and responsibilities for proposal evaluation and source selection; and perceptions of a flawed procurement process leading to protests.

Other Contracting Considerations

Other factors must be considered when planning a procurement that should be taken into consideration prior to releasing the RFP. These factors include agency responsibilities and contract closing.

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[4] For more information see: www.sei.cmu.edu/cmm/cmm.html

[5] For more information, see: http://www.iso.org/iso/en/iso9000-14000/iso9000/iso9000index.html

Agency Responsibilities: In any contract there are certain responsibilities of the purchaser (agency) that are critical to achieve a successful project implementation and in most cases, these responsibilities should actually be identified in the contract. It is very important that the agency assign a project manager to act as the agency single point of contact that is responsible for overall project execution. One of the biggest responsibilities of the project manager will be to ensure timely review and approval of all documentation. Depending on the scope and complexity of the project, this review and approval responsibility can be significant. Examples of documents that may require formal review and approval include, but are not limited to:

- Schedules
- Requirements
- System design
- Equipment specifications
- Testing (test plans and results)
- Project Plans
  - Configuration Management
  - Risk Management
  - Software Development
  - Maintenance
- User manuals
- Training manuals
- As-built plans

In addition to documentation review and approval, there will be a substantial amount of time spent in meetings by the agency including configuration control boards, requirements walk-throughs, and ongoing project management status to name just a few. In some cases, an agency may actually furnish equipment and/or physical space to a contractor.

If the agency does not have the project management resources to review all documentation and participate in training, the project should be scope should be reduced. When a phased implementation (evolutionary system development) is planned, the overall project scope can be retained, but the scope of the individual phases should be reduced. I.e. there will be more project phases. Equally important, if the agency does not have the staff to review and use delivered documentation and to attend scheduled training, these items should not be requested by the statement of work. It is important to have a realistic view of "what can be accomplished" prior to releasing the request for proposals or the invitation for bid.

Contract Closeout: The final step in a systems acquisition is the contract close-out which includes the transition from acceptance testing to operations and maintenance. Prior to close-out, it is important to ensure that all work was completed within the terms of the contract, that all testing has been completed and documented, that all warranties have been met, all required training has been satisfactorily delivered, and that the system has been accepted for maintenance. Formal acceptance of the system for maintenance should be done in writing. In some cases, a procurement audit may be beneficial during contract closeout to identify lessons learned in the procurement process [Schwalbe, 2002].

The contract closeout process should also be defined in the RFP and contract statements of work.

Prepare Operations and Maintenance Plan

It is essential that the agency's plans for operations and maintenance be defined in advance of the system procurement for a number of reasons:

- It is often desirable for the agency to contract with the system developer for operations and maintenance, following system acceptance. If this is the case, the operations and maintenance activities should be defined as an optional task in the RFP and subsequent contract.

- If operations and maintenance is to be performed by others, the system implementation contractor must provide adequate training, spares, documentation and other supporting information and/or supplies to enable the operations and maintenance personnel to meet their responsibilities. Here again, these requirements must be defined in the RFP and contract.

- It is possible that proprietary information will have to be shared with the maintaining organization. These needs must be defined "up front" in the RFP and contract.

Thus, the operations and maintenance plan must include consideration of the manner in which all services will be provided. The plan should identify the organization(s) likely to be performing these services, the scope of their responsibilities, service response times, hours of operation, and information needs. The plan should also include all justifications that might be required for sole source contracts with organizations with unique qualifications; such as knowledge of the software or hardware included in the system.

Release RFP and Select Contractor

At this final step in the procurement processes, the steps of the plans are executed. The steps of proposal preparation, evaluation, and contract award can be labor intensive and time consuming. The work breakdown structure for the procurement prepared earlier should serve as the basis for estimating the schedule that must be executed. Participants in the selection process must be warned in advance, that this is a demanding process to ensure that they reserve adequate time in their schedules for proposal review and attending evaluation panel meetings.

Decision Model Testing

The decision process for selecting the most appropriate procurement package(s) for a given project has been defined in detail in this report. This is a new model that was developed by the project team to provide the logic required by agencies to determine the best approach to procuring ITS systems and other services. However, this is a new process, and for this reason, the team felt that it was important to subject it to real-world system developments to ensure that the results it produced were generally in-line with the recommendations made during prior tasks.

In order to test the decision model, five projects having different characteristics were selected for this purpose. The five projects used for testing are:

- TRANSMIT Expansion
- Baton Rouge, LA FMS/EOC
- Virginia I-81 Corridor ITS Equipment Maintenance
- Brownsville, TX Fixed Route and Paratransit Operations Systems Integration
- Capital Wireless Integrated Network (CapWIN) Project

Table 8 shows the procurement strategies that the decision model recommended for each project. The first two columns show the ITS project description and the system type (see acronym description at the bottom of the table). The following two columns show the project category and organizational level that the decision model assigned to each project after the user responded to a questionnaire that determines the overall category and level scores. Once the project category and organizational level were known, the model recommended the system development process and the related procurement package. The last column shows the actual contracting strategy that was used for that project when this information was available.

The conclusion of this testing was that the recommendations of the decision model are appropriate and are comparable to the ones previously used for the projects. Since these projects are all, generally considered to have been successful, the model is considered to have passed these preliminary tests. This proved to be an extremely useful process, in that it identified gaps in the model's logic that did not cover certain sets of circumstances that occurred during the test. As a result, several modifications to the model's logic were required that did not change the fundamental process, but considered sets of conditions that had not been initially covered.

CONCLUDING REMARKS

This report provides details and definitions for the procurement planning process, including the project planning steps that lead up to this process. The information contained in this report provides the basis for the Contracting Guidelines to be outlined during Task 6 and prepared during Task 7 of this NCHRP project.

Table 8. Decision Model Test Results

ITS Project Description	System Type	Project Cat.	Org. Level	Model Recommendation: System Development Process	Model Recommendation: Procurement Packages	Procurement Strategy Used
TRANSMIT: Install additional transp. readers on Belt Parkway, Van Wyk, Cross Island, etc	FMS Software Development	1	2	Waterfall	SM for software development	N/A
	FMS Field Installation	1	2	Waterfall	DB for field installation	
Expand FMS/EOC in Baton Rouge, LA *Alternative 1**	FMS Software Development	2	1	Evolutionary	SM for software development	N/A
	FMS Field Construction	1	1	Waterfall	DB Consulting services should be used while project is underway	
Expand FMS/EOC in Baton Rouge, LA *Alternative 2**	FMS	2	1	Evolutionary	DB preferred over SM because significant amount of field construction is required. Can use Design Consultant and DB Contractor	N/A
Maintain ITS Equipment in Virginia I-81 Corridor	O&M	2	2	N/A	Other Services being procured. Skips steps 1-4 from decision model. Outsourcing an agency activity: Low-bid selection may be based on rates. Fixed price or time & material contracts. Can use incentives such as performance-based contracting	Work Allocation: Services / Method of Award: Negotiated / Contract Form: Task Order / Contract Type: Incentive
Integrate operations of fixed-route and demand-response paratransit systems in Brownsville, TX	TMS Design	3	2	Evolutionary	SM for software & hardware integration	Work Allocation: SM / Method of Award: Negotiated / Contract Form: Phased / Contract Type : Fixed Price
	TMS Implementation	1	2	Waterfall	Low-bid contractors for field construction and field equipment supply Consulting services should be used while project is underway	
Capital Wireless Integrated Network (CapWin) Project	PS	4	3	Evolutionary or Spiral	SM for software development; Low bid contractor for installation and field equipment supply	Work Allocation: SM / Method of Award: Negotiated / Contract Form: Task Order / Contract Type: Fixed Price and T&M

** For the Baton Rouge project, the decision model recommends two possible alternatives for the procurement strategy. Choosing one or another will depend on the particular preferences and level of experience of the agency.*

FMS = Freeway Management System
SM = System Manager
TMS = Transit Management System
DB = Design Build
O&M = Operations & Maintenance
T&M = Time and Materials
PS = Public Safety