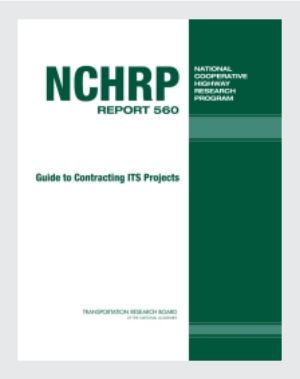

Guide to Contracting ITS Projects

DETAILS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 560

Guide to Contracting ITS Projects

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SUBJECT AREAS
Highway Operations, Capacity, and Traffic Control

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Andrew C. Lemer
Staff Officer
Transportation Research Board

This report provides guidance on the procurement of intelligent transportation systems (ITS), including variable message signs, traffic detectors, signal controllers, and a variety of other hardware and software that entails applications of advanced electronics and information management to regulate and facilitate traffic flow. This guide should be useful to government officials, traffic engineers, system integrators, and others involved in the specification and purchasing of ITS installations.

Intelligent transportation systems (ITS) procurements often entail sophisticated assemblages of electronic equipment and software that are challenging to specify because they are tailored to the unique requirements of the procuring agency and use components embodying technology that can advance substantially in the time between an installation's conception and realization. Because of these complexities and uncertainties, the low-bid contracting process that transportation agencies traditionally use to purchase capital improvements often is not the best approach for ITS procurements.

Experience has shown that the ITS procurement method can have substantial influence on the ultimate success of the ITS installation. The procurement method determines how responsibilities are distributed and decisions are made, the qualifications of the contractor, the systems engineering process, and the controls available to the contracting agency. The procurement method, ideally selected to suit the characteristics of the procuring agency as well as those of the project, can make or break a project.

The objective of this research was to develop a guide to contracting ITS projects and services, which would highlight best practices and recommend contracting strategies and contract types, terms, and conditions for ITS development, integration, system acceptance, warranty, maintenance, and upgrade. The research was designed to address these matters at all levels, from determining an overall procurement strategy that is compatible with a systems engineering process; to selecting appropriate contract types and defining contract deliverables, managing the contract and change orders, validating and verifying software, and accepting the system; to addressing ongoing system support.

Under NCHRP Project 3-77, "Guide to Contracting Intelligent Transportation System Projects," researchers at Edwards and Kelcey, Inc. (1) reviewed the transportation and technology literature to identify effective contracting methods and their strengths and weaknesses, augmenting the review by surveying state and local transportation agencies; (2) identified contracting methods used in other industries that might be suitable for ITS procurements in the transportation industry; (3) characterized ITS projects based on the project complexity, level of new development required, scope and breadth of technologies involved, amount of interfacing to other systems, likelihood of technology evolution, and fluidity of system requirements; (4) described how a systems engineering process may be

incorporated into the various contract types and assessed the impact of changing technology and requirements, from project conception to completion, on the contract and the potential implications for contracting flexibility; (5) recommended contract types, including new, innovative approaches, for the likely range of ITS procurements; and (6) prepared the guide presented here.

In addition to this guide, the research team prepared a final report describing their work and many interim results that may be of value to other researchers and professionals facing ITS procurement issues. That report is being published simultaneously as *NCHRP Web-Only Document 85* (www4.trb.org/trb/onlinepubs.nsf/). Finally, the researchers developed an on-line tool that applies the guide's decision-making process; the tool may be accessed from the project description on the TRB web site (www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+3-77).

CONTENTS

About This Guide

A corridor within the operating jurisdiction of your transportation agency has experienced a high accident rate. Funding has been made available for your agency to design, procure, and install closed circuit television (CCTV) to monitor the corridor. You have been assigned as the project manager. How will you procure the goods and services needed to successfully complete the project?

Most likely, your agency is responsible for maintaining mobility and safety goals for a defined transportation network. (A transportation network is generally defined by state and local geographic boundaries.) Traditionally, this goal has been accomplished by increasing capacity through the development of infrastructure. Throughout the years, the processes and procedures required to successfully facilitate infrastructure development have been institutionalized within your agency. In recent years, primarily due to land-use decisions and right-of-way restrictions, infrastructure development has been determined to no longer be the principal solution to address mobility issues. Transportation agencies, similar to yours, are beginning to reallocate resources to support infrastructure management and operations versus infrastructure development. This phenomenon has resulted in an institutional shift requiring the use of new processes and procedures (including innovative procurement processes and procedures) for improved management and operation.

Federal legislation dating back to the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 recognizes intelligent transportation systems (ITS) as a viable tool for improving the management and operation of existing transportation network infrastructure. ITS is generally defined as the application of advanced technologies (i.e., CCTV) to improve the efficiency and/or safety of a transportation system. The ITS functions are defined by the FHWA National ITS Architecture.

The successful procurement of ITS is a challenging task for state and local transportation agencies. The procurement process must be flexible to accommodate the uncertainties of complex system acquisitions, but, at the same time, structured 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.

Although you have several options for procuring your ITS project, some options are more appropriate than others. This guide presents a decision model that will help you identify the most appropriate procurement options.

Assumptions About the Reader

This guide is intended for individuals responsible for procuring ITS. It is recommended that users of this guide have the following basic skills and/or background:

- An understanding of ITS
- An understanding of the risks associated with the procurement of ITS
- An awareness of state procurement regulations, policies, and practices
- An awareness of federal procurement regulations, policies, and guidelines
- A general understanding of systems engineering with respect to project development
- Familiarity and experience with project management principles of high-technology projects

Guide Organization

Many factors must be considered when you are tasked with identifying an appropriate procurement process for an ITS acquisition. A Decision Model has been developed for this guide to aid in this activity. The Decision Model is rooted in the relationship among the four dimensions of procurement (work distribution, method of award, contract form, and contract type) along with the systems and systems engineering concepts they support. This guide is organized based on the Decision Model presented in Figure 1.

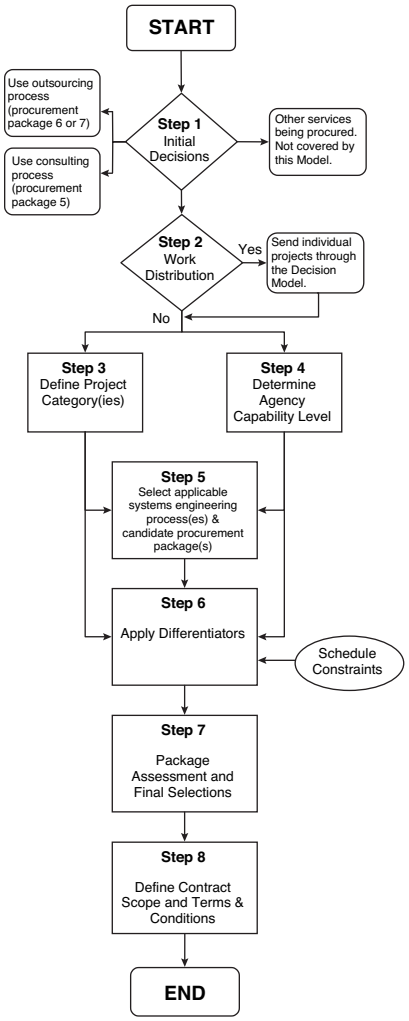


Figure 1. Decision model.

The Decision Model includes eight steps that must be performed to complete the process of defining the most appropriate procurement approach for your project:

- **Step 1—Make Initial Decisions:** Step 1 will aid you 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 you to skip to Step 7 of the Decision Model if either outsourcing or consultant services are used.
- **Step 2—Determine Work Distribution:** Step 2 will help you determine whether the procurement should be performed as a single contract or multiple contracts.
- **Step 3—Define Project Category:** Step 3 will help you 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 4 will assist you in assessing your agency's resources and capabilities as well as the environment in which your project will be procured.
- **Step 5—Select Applicable Systems Engineering Process and Candidate Procurement Package:** Step 5 uses the results of Steps 3 and 4 to select applicable systems engineering processes and candidate procurement packages.
- **Step 6—Apply Differentiators:** Step 6 applies differentiators to the candidate procurement packages to help you reduce the number of procurement packages identified in Step 5.
- **Step 7—Assess Package and Make 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 and Terms and Conditions:** The final step will assist you with the selection of the necessary terms and conditions to be included in the contract.

Each step is explained in the corresponding section of the guide. The Decision Model graphic is used throughout the guide to highlight your progress.

To emphasize pertinent information, tips, notes, key points, references, and innovative concepts are highlighted throughout the guide. The following icons will be used to alert you to pertinent information.

The **tip icon** is used to alert the reader to lessons that guide authors and contributors have learned through experience in the procurement of ITS.

The **note icon** is used to explain to the reader, in greater detail, concepts that are put forth throughout the guide.

The **key point icon** is used to alert readers to points critical to the successful procurement of ITS.

The **reference icon** is used to inform readers of additional references that provide further explanation of a specific topic discussed in the guide.

The **innovative concept icon** is used to alert readers to novel strategies and practices used to procure ITS.

Before We Get Started

As stated earlier, the procurement of ITS is a challenging task. This guide should be considered as a tool to be used to overcome this challenge. But before you begin using the guide, you should review the topics covered in the following sections:

- Project planning
- The procurement process
- Systems engineering as it relates to contracting

For more information on this subject, refer to the final report, NCHRP Web-Only Document 85.

Project Planning

Before identifying appropriate procurement options (termed *procurement planning* in this guide) for your ITS project, you must first establish project feasibility and then consider commercial off-the-shelf (COTS) versus custom system development and outsourcing.

These initial considerations (termed *project planning* in this guide) ensure that project stakeholders achieve consensus on the functional expectations and resource requirements of the acquisition in order to facilitate a successful project. These activities should be performed before the actual procurement of services or equipment and can roughly be divided into the two major categories of project planning and procurement planning (see Figure 2).

Project planning is further explained in NCHRP Web-Only Document 85.

Project Feasibility

Stakeholders establish project feasibility by first agreeing on the project concept of operations (how the project will be used). Institutional, financial, and temporal constraints should be considered. Based on the identified concept of operations, stakeholders develop a project scope, schedule, and cost estimations. Project feasibility is established once the project scope, schedule, and cost estimations have been validated and verified against available agency resources.

Establishing project feasibility will help you answer the following questions:

- How much will the system cost and can you afford it?
- Do you have a reasonable schedule, or are your deadlines unrealistic?
- Do you have adequate personnel (both in numbers and skills) to manage and support the development?
- Does everyone share the same vision for the system? Is there universal agreement regarding the manner in which the system will be used?

Once the project's feasibility has been established, you should consider the use of COTS products (hardware and software). In addition, you should consider the possibility of outsourcing.

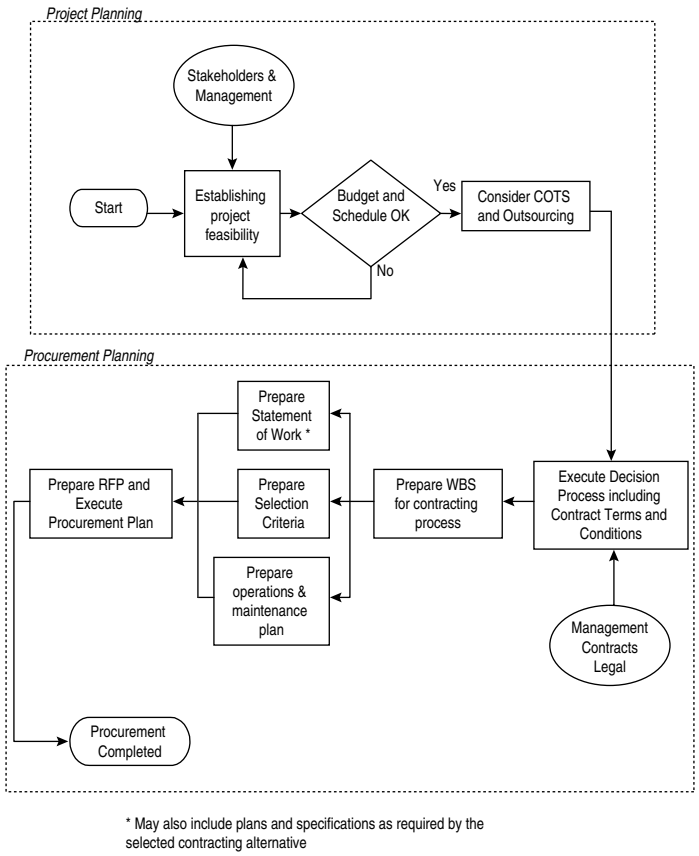


Figure 2. The planning process

COTS versus Custom System Development

You should look for opportunities to use COTS products wherever possible. It may be that minor adjustments to the concept of operations will permit this approach.

Frequently, the system that your stakeholders defined while establishing project feasibility has been developed and procured by another agency. This reality results in a favorable scenario for you. ITS that have been previously installed are considered COTS systems. *If at all possible, you should contact peer agencies to acquire lessons learned from their experience procuring the system that your agency is interested in procuring.* Additional benefits accrue with procuring COTS systems:

- The system has been previously tested.
- The cost for system upgrades can be shared with other agencies.
- The system can be viewed in operation before system procurement.

In contrast, your project stakeholders may define a system that has not previously been installed—a *custom* system development. In some cases, it may be best to procure a hybrid system that includes both COTS and custom components.

Outsourcing

Outsourcing is the process by which organizations (public or private) use external providers to manage or maintain certain aspects of their businesses. *While establishing project feasibility, stakeholders may realize that the group does not have the personnel (skills or resources) to design, procure, deploy, operate and/or maintain the defined system. In this case, outsourcing may be prudent.*

The Procurement Process

The procurement process includes four dimensions: work distribution, method of award, contract form, and contract type. Once these key procurement decisions have been made, appropriate terms and conditions can be identified.

Work Distribution

The work distribution dimension divides the project responsibilities defined by the agency for the contractor by the contract statement of work into assignments expressed in systems engineering terminology—concept of operations, requirements, design, implementation, and testing. The assignments also include the crosscutting activities of configuration management, risk management, validation and verification, and metrics. The assignments can be grouped into the following forms of work distribution:

- **Low-bid contractor**—The selection of a contractor for systems installation using the low-bid process. The low-bid contractor is responsible for furnishing a fully operational system including all hardware, software, and construction services required to satisfy a detailed design defined by plans and specifications.
- **Systems manager**—An organization whose responsibilities may include all project activities associated with a systems acquisition except for the provision of equipment, electrical contracting, and construction contracting.
- **Systems integrator**—Similar to 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 except for the provision of equipment, electrical contracting, and construction.
- **Design-build (operate and maintain) (DB [OM])**—A (single) contractor or private developer provides for the design and construction of improvements. 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. The design-build contractor's work is based on an initial design that may be prepared by a consultant.
- **Commodity (COTS)**—Contracting for the acquisition of commodities is applicable to ITS contracting to the extent that an agency is procuring COTS products. These products may include field equipment such as variable message signs, traffic signal controllers, radios, or computers. They may also include COTS software and systems.
- **Consultant Services**—Work provided by consultants is limited to provision of personal services. Some of the ways in which consultant contracts may be used include systems design and installation support, inspection, design, and documentation and training.
- **Services**—Contracts for other forms of services are frequently awarded during the life cycle of an intelligent transportation system. The differentiation is made here to identify services that are outside the mainstream of system development, such as inspection, independent validation and verification (IV&V), outreach, internet service providers (ISPs), and staff supplements.

Method of Award

The method of award dimension of procurement defines the criteria used and steps taken to select a contractor to perform the work. As indicated below, there are distinct differences among the various methods of award. These differences should be taken into account when selecting a

form of work distribution because the work distribution form determines the method of award. The following are the methods of award:

- **Low bid**—Low-bid contracting, commonly referred to as sealed bidding, is a contracting method that employs competitive bids, public openings of bids, and contractor selection based on the lowest price offered.
- **Negotiated**—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. 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.
- **Sole source**—Sole-source procurement is the direct selection of a contractor without competition.
- **Best value**—Selection is made on a weighted combination of the technical approach, qualifications, experience, and price of the offeror. Best value is, in effect, a combination of the low-bid and negotiated methods of award.

Contract Form

The three contract forms define the manner in which work is authorized:

- **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 sets of predefined activities (or phases) with specified deliverables.
- **Task order (or indefinite delivery) contracts**—Task order 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 an overarching "umbrella" contract.
- **Purchase orders**—A purchase order is a form of sole-source contracting used for relatively small procurements. 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

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 the following range of alternatives:

- **Firm, fixed price**—The contractor assumes full responsibility for the performance costs and any profit or loss at a fixed price.
- **Cost reimbursable**—The contractor is paid (reimbursed) for his actual costs of performing the work and the fee (profit) is fixed.
- **Time and materials**—The contractor is paid for his actual costs of performing the work, and a percentage fee is added to all payments.
- **Incentives**—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. Incentives are paid in addition to the three types of previously described reimbursements.

For firm, fixed-price contracts, the contractor assumes all of the financial risk. The agency assumes all of the financial risk for time and materials contracts. Financial risks are shared in cost-reimbursable contracts.

Terms and Conditions

Terms and conditions are defined in Step 8 of the Decision Model process.

The procurement process is defined by the Federal Acquisition Regulations (FAR). Title 48 of the Code of Federal Regulations Chapter 1 codifies the FAR. The FAR presents policies for acquisition of supplies and services by executive agencies. The FAR is available on the internet at www.arnet.gov/far. But the FAR is not the only source of regulations. All state and local government agencies have their own processes that also must be followed.

Systems Engineering as It Relates to Contracting

The "V" diagram, shown in Figure 3, has been developed by the systems engineering profession to define the relationship among the phases of the system life cycle. As represented in the figure, the systems engineering process begins with the early planning activities, during which the system's relationship with regional needs and other regional systems is defined. The central "V" shape, which begins with the systems engineering management plan and ends with operations and maintenance, includes the activities specifically associated with the acquisition of the system with which these procurement guidelines are concerned. The arrow in the "V" diagram shows the time sequence of these activities. The oval shapes are known as control gates and identify the points in the process at which specific documentation is required and decisions regarding the ongoing development must be made.

As indicated in the diagram, the life cycle must consider not only the specific steps associated with the system planning, design, and development, but also the regional context for the system (on the left side of the diagram) and the need for system upgrades and enhancements as shown on the right side of the diagram.

Alternative process models can be applied to the system life cycle relationships defined in the "V" diagram to systems engineering. A well-developed model also supports the project management process in that it defines the system acquisition steps and helps convey to the project team and others how a project will be managed. *The process model influences the selection of the*

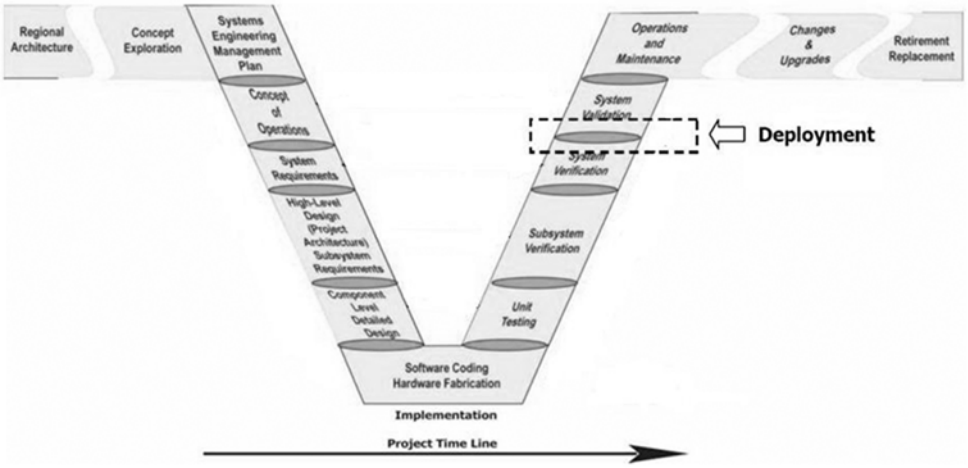


Figure 3. "V" diagram of systems engineering.

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 alternative paths, and it helps to take advantage of emerging opportunities. The following models can be used as alternative systems engineering processes:

- Waterfall model—Linear process used for relatively simple projects.
- Evolutionary model—Incremental approach to systems engineering in which the system is implemented in small pieces. Applicable to complex systems.
- Spiral model—A model characterized by extensive prototyping and planning. This model is used where a complex system includes new untested concepts and functionality.

The Decision Model

The following considerations set the stage for applying the Decision Model, which is based on the characteristics of the project and capability level of the agency. More precise terminology will be defined later. The model has been developed with the following considerations in mind:

- The characteristics of the ITS project you are implementing has a major influence on the contracting approach.
- *Your agency's experience/environment has a major influence on the contracting approach.*
- The systems engineering process has major influence on contracting approach.
- Defining the project, agency experience with ITS, and systems engineering process will allow selection of the appropriate contracting approach.
- There are four basic contracting alternatives (procurement packages 1 through 4 identified in Table 1). The other contracting alternatives are adjustments to these packages.
- Contract terms and conditions are an important element of the contracting process. They are defined once a package has been selected.

The Decision Model used in this guide represents the results of multiple reviews, as well as the testing of the process with five real-world systems.

The four dimensions of procurement shown in Figure 4, along with the terms and conditions, provide a structured representation of the contracting process (procurement). The purpose of the procedure described in this section is to select the combination of procurement characteristics (one from each of the four dimensions) that are most appropriate for the project's characteristics and the agency's capabilities.

Only a few combinations of procurement characteristics are practical. Contracting packages are unique combinations of procurement characteristics, selected from each of the dimensions of Figure 4. 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 distribution dimension of Figure 4, which is the fundamental variable that drives the entire process.

The characteristics contained in each of the seven procurement packages 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 (i.e., an internal agency process such as inspection, maintenance, operations, mowing, or signal timing) and functions (i.e., an entire agency service such as traffic management, traveler information or toll collection) in a manner that reduces the agency's staffing requirements.

The objective of the selection process is to choose 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.

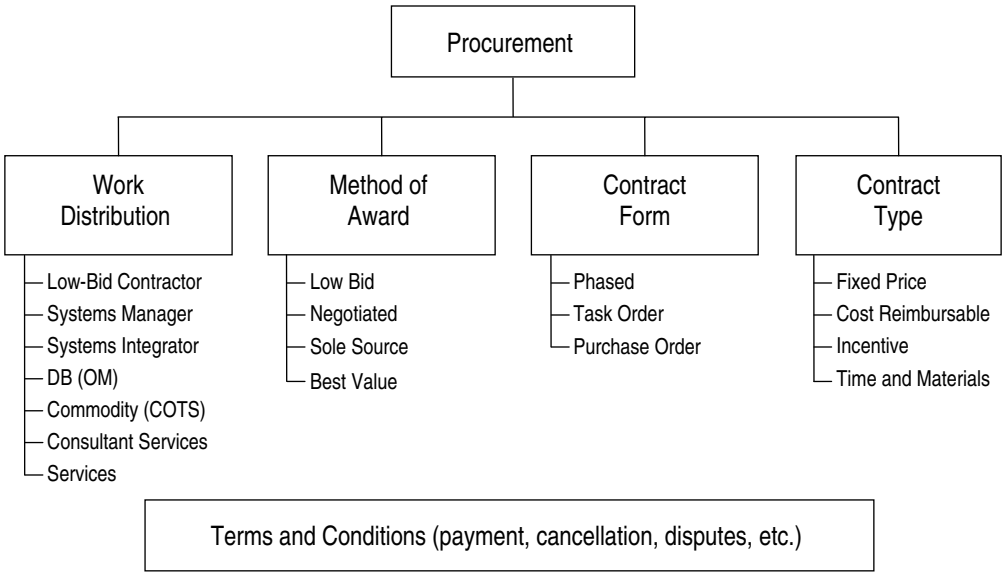
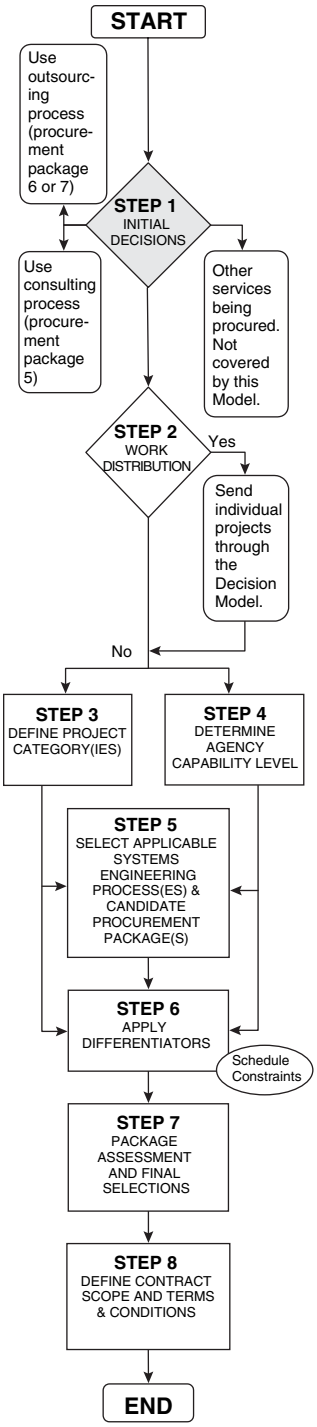


Figure 4. Four dimensions of procurement.

Table 1. Procurement packages.

Package No.	Work Distribution (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 Design Consultant	Low-bid selection for contractor	Phased / task 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	Fixed price, cost reimbursable, 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 reimbursable, or time & materials; incentives optional	Consultant provides 30% design.
5	Consultant	Negotiated	Phased / Task Order	Fixed price, cost reimbursable, or time & materials incentives optional	Used for system design and many other consultant services.
6	Outsourcing Agency Activity	Low-bid selection 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 selection	Single phase	Fixed price, cost reimbursable, or time & material; incentives optional	Typical functions include traveler information and toll collection. May be public-private partnership.



Step 1—Make Initial Decisions

Now you are ready to get started with the first step of the Decision Model. This first step actually involves a series of substeps designed to help make some initial decisions about the fundamental project characteristics that differentiate a system development, a consultant contract, and an outsourcing contract. These subjects have been discussed earlier during the project planning activities.

The logic for Step 1, diagrammed in Figure 5, leads to four possible outcomes; one of which involves moving on to Step 2 of the Decision Model.

Most system developments will

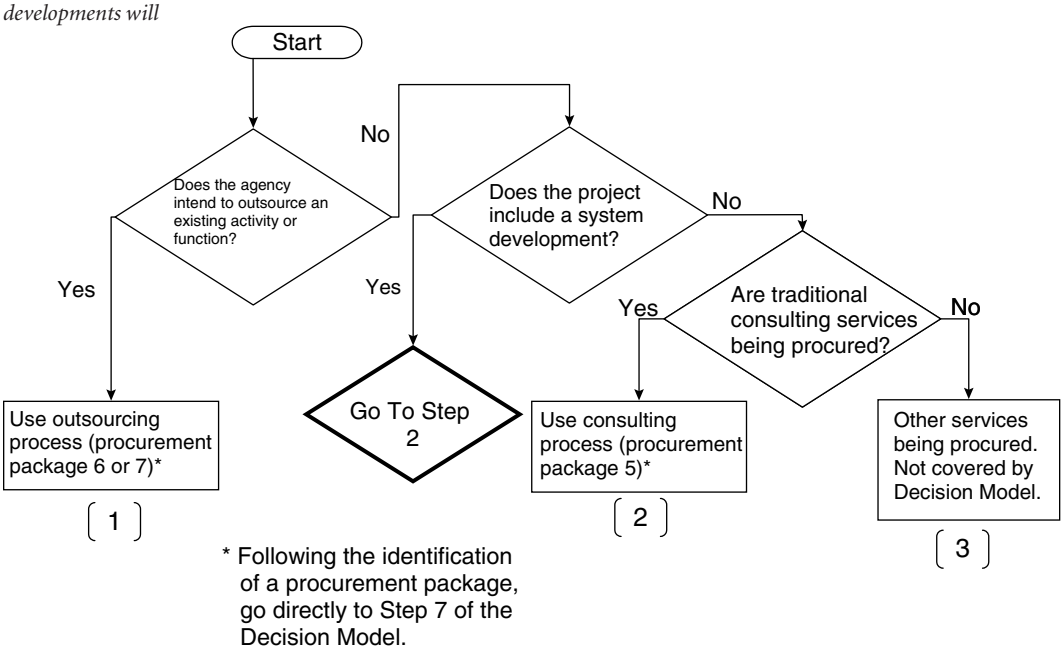


Figure 5. Initial project-planning decision process.

Three other outcomes to the initial decision process are possible. These outcomes are identified by the bracketed numerals 1 through 3 in Figure 5 and in the following descriptions.

[1] This outcome indicates you are planning to outsource an existing agency activity or agency function. Select procurement package 6 or 7 and go directly to Step 7 of the Decision Model process.

[2] This outcome indicates a focus on the use of traditional consulting procurement processes as associated with procurement package 5. Select procurement package 5, and go directly to Step 7 of the Decision Model process.

[3] This outcome indicates that you are procuring services not addressed by any of the procurement packages covered within this guide. For example, procurement packages specific to public-private partnership contracts are not covered.

Step 2—Determine Work Distribution

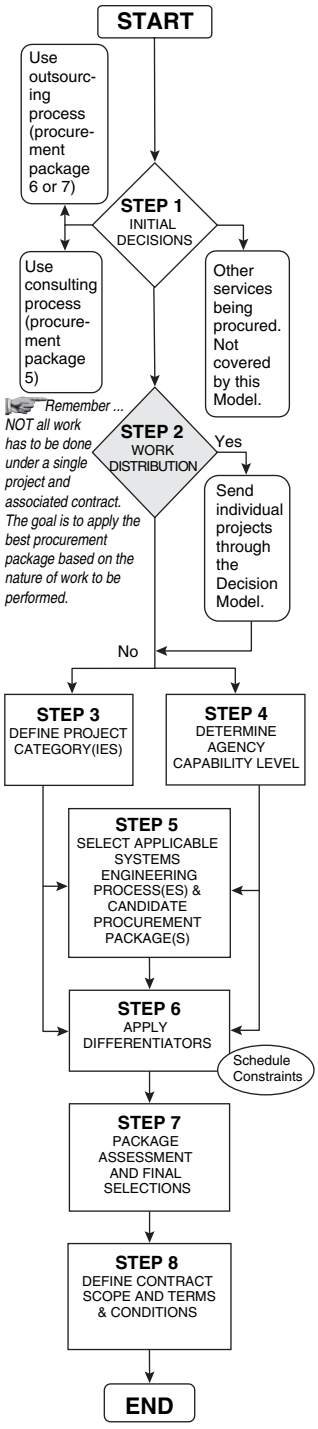
You've determined that you are moving forward with the steps required for identifying an appropriate procurement package for your systems development project. You've already done a significant amount of work to get to this point, and the Decision Model process will guide you the rest of the way.

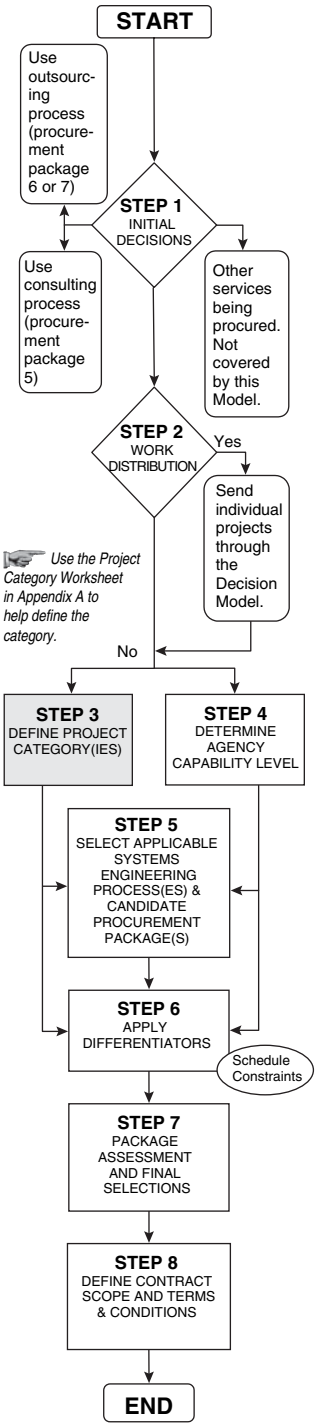
The second step in the Decision Model determines whether the procurement should be performed as a single contract or multiple contracts. Step 2 occurs early in the process to enable each specific contract resulting from this step to go through the Decision Model process and to be executed using a contracting process and associated procurement package that best addresses the nature of work to be performed. For example, one contract may include the central system (including software) implementation, while another contract may consist of only field equipment installations. Many ITS procurements involve multiple contractors who have been selected using different procurement packages.

Thus, this step of the Decision Model distributes the total work associated with a project to multiple subprojects and their related contracts. It may very well be that only a single contract is required for the entire project. 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, systems design, website design, or IV&V of the contractor's work. The reasons to distribute work to multiple contracts as opposed to performing all work under a single contract may include the following:

- Although a significant amount of software and systems development is needed, the largest dollar amount is in construction (i.e., the systems contractor will not be prime unless separate contracts are issued for the systems contractor and the construction contractor).
- The likelihood of selecting a satisfactory prime contractor for the overall project is uncertain (i.e., not putting all of "one's eggs in the same basket" would be prudent).
- "Politics" require the work to be spread around (which might be particularly true if the project involves a significant amount of field construction).

Unless there are compelling reasons to do otherwise, software development and systems integration work should be performed by the prime contractor, to ensure a single point of responsibility and to minimize the complexities of managing the development environment.





Step 3—Define Project Category(ies)

Now that the work has been distributed to a single project or multiple projects, the third step of the Decision Model involves categorizing each project in terms of its overall complexity and risk. Six factors have been selected to help define complexity and risk: level of new development, scope and breadth of technologies, interfaces to other systems, technology evolution, requirements fluidity, and institutional issues.

Table 2 shows how each factor contributes to the definitions of the four ITS project categories. *The worksheet in Appendix A has been developed to help guide project categorization.* The worksheet identifies the characteristics of each factor and assigns these factors to the following categories of overall complexity and risk:

- 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

This step and all subsequent steps must be executed for each of the projects defined during Step 2.

It is unlikely that the project will fit all of the descriptors within a single category of Table 2. Thus the challenge of this step is to find the overall set of descriptors that best matches the project's characteristics. This process is not an exact science; therefore, some degree of judgment must be used. As a general rule, the higher categories entail a greater development risk because these categories contain more unknowns, expressed using such factors as the level of new development entailed and the requirements fluidity. These two factors should receive the highest priority when evaluating the project category. While the worksheet in Appendix A will identify an ITS project category range, in the event that the project appears to be equally suited to two different categories, the higher category should be selected.

Once you have selected the project category, don't forget your answer.

Don't forget the ITS project category once you've decided upon it. It will be used along with your defined agency capability level (Step 4) to select an appropriate systems engineering process and initial procurement package(s) (Step 5).

Table 2. ITS project categories and associated characteristics.

Factors	Category 1 Straightforward Low Risk	Category 2 Moderately Complex Moderate Risk	Category 3 Complex High Risk	Category 4 Extremely Complex Very High Risk
Level of New Development	Little to no new software development / exclusively based on COTS software and hardware 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 multiple-phase 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 two or three). May be single stand-alone project, or may be part of multiple-phase 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 known but includes one or more interfaces to new and/or 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.

(continued on next page)

Table 2. (Continued).

Factors	Category 1 Straightforward Low Risk	Category 2 Moderately Complex Moderate Risk	Category 3 Complex High Risk	Category 4 Extremely Complex Very High Risk
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 into 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.

Step 4—Determine Agency Capability Level

Selection of a procurement package *cannot* be based solely on a project's complexity and risk. Equally critical to procurement package selection is an honest assessment of your agency's resources and capabilities as well as the environment in which your initiative is planned, designed, deployed, and operated. Does your agency have personnel with relevant prior ITS project experience? Is there management support for dedicating adequate resources throughout your ITS project's life cycle? What exactly are the expectations of agency management and can these expectations be met (realistically)?

The fourth step in the Decision Model is designed to help you answer these questions. *This step uses the information in Table 3 and the worksheet in Appendix B to determine the level that best suits your agency's capability to manage the system acquisition.* In essence, this step is used to assess your agency's organization, experience, and resources relative to ITS procurements.

A careful and thorough assessment is important. While the tendency may be to look at your agency's capabilities in a favorable light, overlooking deficiencies in, for example, experience and resources is a recipe for failure. Major ITS projects with significant software development, hardware integration, and, perhaps most critical, *long-term* operations and maintenance support can be challenging for even the most experienced agency. *If you and your agency are not quite ready to take on a project, then either don't do it or reduce the project scope to a manageable size and complexity.* It might also be prudent to bring on additional consultant resources. Don't take on a system that will result in a long-term operations and maintenance commitment if you haven't identified the resources to maintain it. If pressure "from above" is an issue, use this guide to make a case for performing the additional planning and preparation necessary to acquire the experience, resources, and management support for taking on the challenges of an ITS project and making it a success.

As in the previous step where project categories were defined, some degree of uncertainty is likely to exist regarding the capability level of the agency's organization. In this case, personnel and organizational experience should receive the greatest weight. In the event that you think your agency is described equally well by two levels, be conservative and select the lower one.

Now that you've figured out your project category(ies) and have done an assessment of your agency's ITS-related capabilities, you're ready to move on to the next step, which will begin to reveal some initial results of the Decision Model.

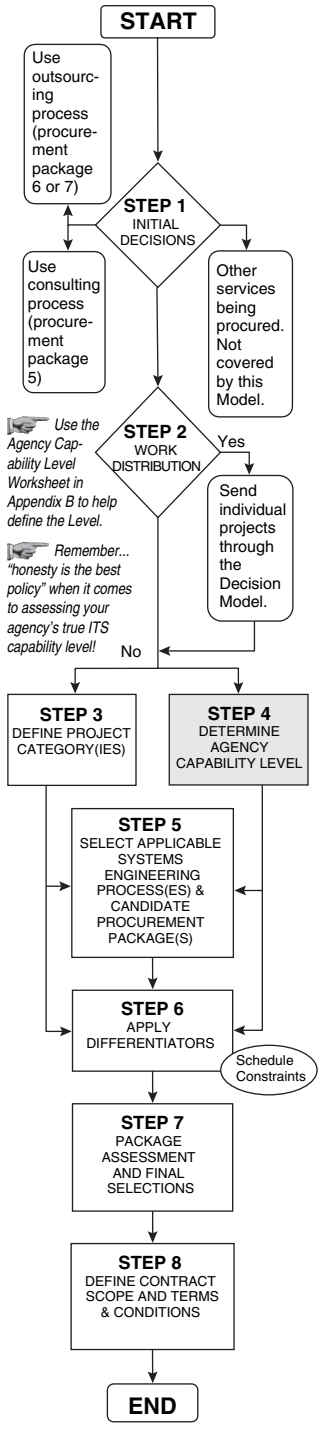


Table 3. Agency capability levels as a function of characteristics.

Characteristic	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 project(s).	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 among 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 among these units. An umbrella ITS organizational unit may exist, but may not have the budgetary authority to effectively manage subunits.	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 existing budget of organizational unit(s).	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 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 whether they have 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.

Step 5—Select Applicable Systems Engineering Process(es) and Procurement Package(s)

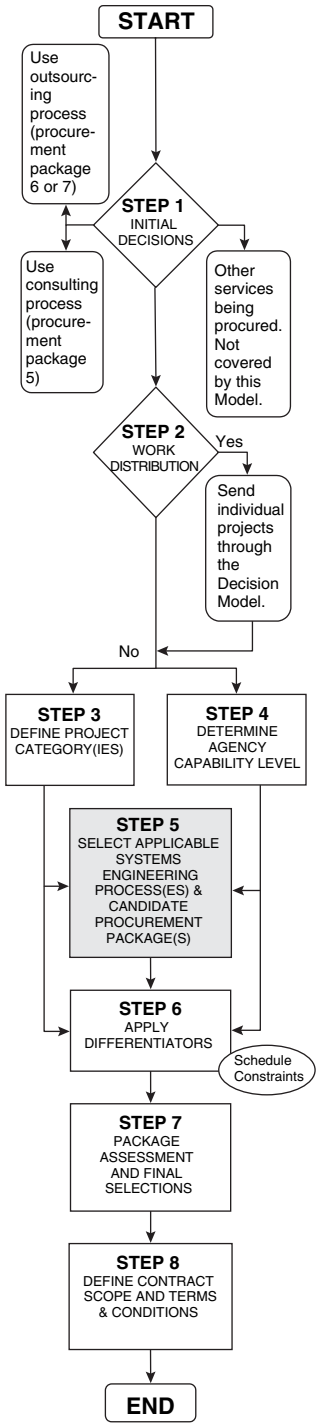
At the completion of Step 5, you will have identified at least one systems engineering process and contracting package appropriate for your systems development project. In all likelihood, this step will result in a number of candidate process and package alternatives. Subsequent steps will help you decide between them.

Before executing this step, let's review the alternative systems engineering processes that could be applied to your situation. The alternative processes (also known as models) are the waterfall model, the evolutionary model, and the spiral model, all of which are explained in detail in *NCHRP Web-Only Document 85.*

The waterfall model is representative of typical highway design and construction processes in which steps of planning, design, and implementation are performed sequentially. This model is used for less complex ITS projects and can be applied under all agency capability levels.

The evolutionary model defines a repetitive 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 applicable to all but the simplest ITS projects or projects that require the development of new, unproven technologies. It should be used by all agency levels for most systems development projects. The idea behind this model is to divide complex systems development into relatively simple implementation stages that will ultimately result in the successful deployment of the complete system by the end of the final phase. However, remember that an ITS project will never truly end as the deployed system will *always* require ongoing operations and maintenance support.

The spiral model is appropriate for the development of new applications involving previously untested capabilities that require a lot of planning, prototyping, and evaluation. This model is rarely used by the ITS community, because 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 has been used within the ITS community for 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 agency with an experienced, full-time ITS manager and staff is recommended. The spiral methodology involves multiple cycles of prototyping and feedback requiring significant agency staff time. A Level 2 agency with significant consultant resource support (assuming this can be obtained) could oversee this development model but at greater risk for failure. A Level 1 agency would not have the experience, structure, or resources to appropriately manage and be involved in this development process.



This step is based on work associated with Task 4 of NCHRP Project 3-77, which supported development of this guide. Please refer to NCHRP Web-Only Document 85 *for additional detailed information on the systems engineering process models.*

Now that you've completed our review of systems development processes and their relationship to project categories and agency levels, let's actually execute Step 5. Use the columns (agency capability) and rows (project category) of the matrix in Table 4 to locate the cell that identifies the applicable procurement package or packages.

The commodity entries in this table indicate 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 may be acquired by the contractor or in some cases, the agency will procure the COTS product for the contractor using a commodity procurement.

Many of the cells in the matrix provide multiple procurement packages and systems engineering models. Step 6 will provide you with information that can be used to decide 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. *Remember, as with the previous step, no amount of optimism can be used to overcome fundamental shortcomings in experience or resources!*

Table 4. The decision matrix for Step 5.

Project Category	Agency Capability Level		
	Level 1	Level 2	Level 3
1 – Straightforward	• Waterfall • SM*	• Waterfall • Low bid*, commodity, or systems manager	• Waterfall • Low bid, commodity, or systems manager
2 – Moderately Complex	• Evolutionary • Systems manager or design-build*	• Waterfall or evolutionary • Low bid*, systems manager, or design-build	• Waterfall or evolutionary • Low bid, systems manager, or design-build
3 – Complex	Not recommended	• Evolutionary • Systems manager or design-build	• Evolutionary or spiral • Systems manager or design-build
4 – Extremely Complex	Not recommended	• Evolutionary or spiral • Systems manager or design-build	• Evolutionary or spiral • Systems manager or design-build

Notes:
First line is the systems engineering model; second line is the procurement package.
* Consulting services should be used while project is under way.

Step 6—Apply Differentiators

Step 6 should be used when more than one type of procurement package is identified by Table 4 in Step 5. Step 6 uses the following criteria to help you reduce the number of alternatives:

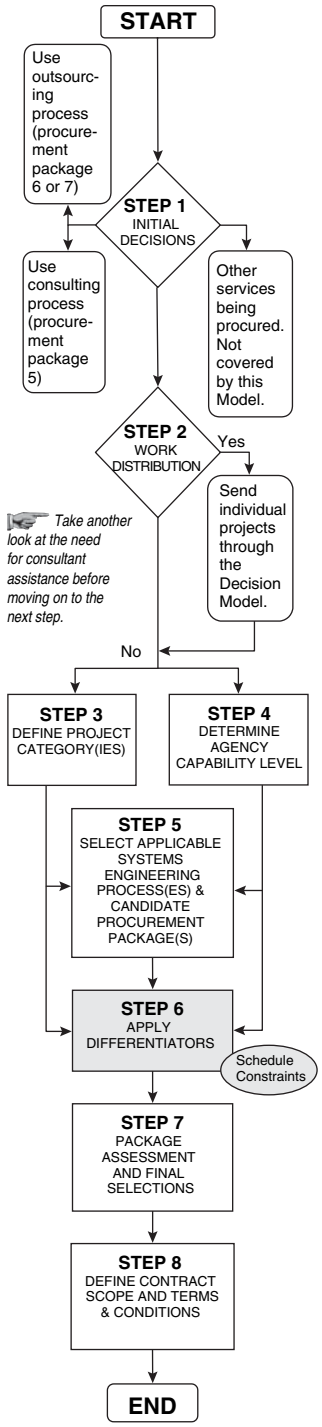
- Systems manager is preferred to design-build when a significant amount of new software development is required.
- Design-build is preferred over systems manager only for major projects when significant amounts of field construction are involved and there is a desire to reduce implementation delays associated with having to administer multiple procurement contracts. *The schedule constraints input into this step (as depicted in the Decision Model diagram) highlights the time constraint of implementing a complex system, which makes design-build a potentially attractive alternative.*
- The evolutionary systems engineering model is generally 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, untested, new developments are required.
- If a project includes both new software and field construction, consider splitting it into multiple contracts.
- Low-bid contracting should be used only
  - In the unlikely event that it is required by agency policy, or
  - If projects are limited to field construction and supply of off-the-shelf equipment.
- Commodity procurement is applicable if an existing ITS 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,
  - A new database reflecting system configuration, and
  - New map graphics.

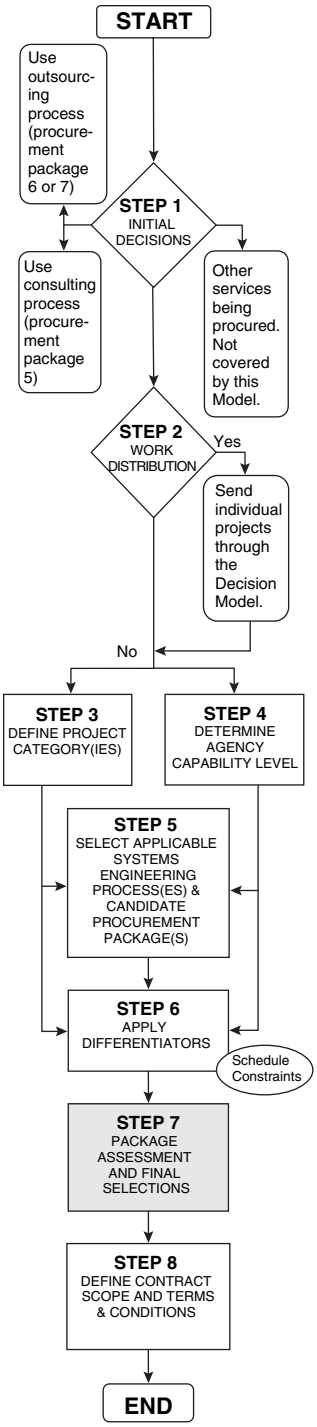
If, after considering these differentiators, you still find yourself with multiple solutions, work with your agency's procurement officials to select the preferred alternative (Step 7).

Before moving on to Step 7, you may need to re-assess the need for consulting assistance and/or provision of field construction and field equipment supply. In Step 1, this assessment was based on overall considerations of the extent and type of work to be performed. During Step 6, the needs of the contracting package for consulting assistance should be reviewed. Other approaches also might require consulting assistance as defined by procurement package 5. For example, the following contracting packages may require consulting assistance:

- A 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. Therefore, two contracts will be required: one for the design consultant and a second for the low-bid implementation contractor.
- A 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. Therefore, 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.
- A design consultant must prepare a 30% design to be used for the selection and negotiations with a design-build contractor. Therefore, 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—Assess Package and Make Final Selections

Step 7 must be performed for all procurements. *If you have not already done so, at this point it is imperative to discuss procurement package selection with agency procurement personnel.* You may also want to include legal personnel to discuss intellectual property rights, as well as contract terms and conditions of Step 8.

In the event that multiple procurement alternatives exist at the conclusion of Step 6, make the final selection of the preferred alternative cooperatively with your procurement staff. This decision must consider your agency policies and should possibly give preference to alternatives with which your agency has had prior experience.

Take advantage of the expertise from your agency's IT department.

However, prior experience should not be limited to your agency's experience with highway construction. You may very well be able to take advantage of the expertise of information technology (IT) personnel that already exists either within or outside your procurement department. This expertise can take the form of technical expertise (e.g., hardware, software, and communications) or even IT procurement expertise. While coordination with IT staff is encouraged, relinquishing authority for 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** recommended.

Step 8—Define Contract Scope and Terms and Conditions

The final step in the Decision Model involves the selection of the terms and conditions to be included in the contract. As with Step 6, you'll want to do this step in close collaboration with your agency's procurement personnel. Although 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, systems manager, and design-build contractor). The following list of mandatory contract terms and conditions should be considered regardless of procurement package used:

- Parties to the contract
- Scope of the contract
- Compensation and method of payment
- Extras
- Assignment of claims
- Agency-furnished property
- Order of precedence
- Commercial warranty
- Patent rights
- Multi-year contracts contingent upon appropriations
- Termination for default
- Termination for convenience
- Execution and commencement of work
- Delays and extensions of time
- Modifications
- Multiple contract awards
- Liquidated damages
- Variations in estimated quantities
- Suspension of work
- Incorporation by reference
- Specifications
- Delivery and acceptance
- Intellectual property
- Contractor's invoices
- Conflicting terms

Table 5 identifies terms and conditions that are most appropriate to specific procurement packages. The section following Table 5 provides definitions for all of the terms and conditions in both the above list and Table 5.

ITS is not explicitly referenced in the FAR. Relevant information can be found in sections referencing IT.

Your agency is likely to have standard sets of terms and conditions that are to be incorporated in the request for proposals and resulting contract. In the unlikely event that standard terms and conditions are not available within your agency, or if you are looking for guidance on a specific term and condition not typically used by your agency, the Federal Acquisition Regulations (FAR) is a good source of information. The FAR, which governs the majority of federal procurements, includes language for myriad terms and conditions including those appropriate to ITS projects.

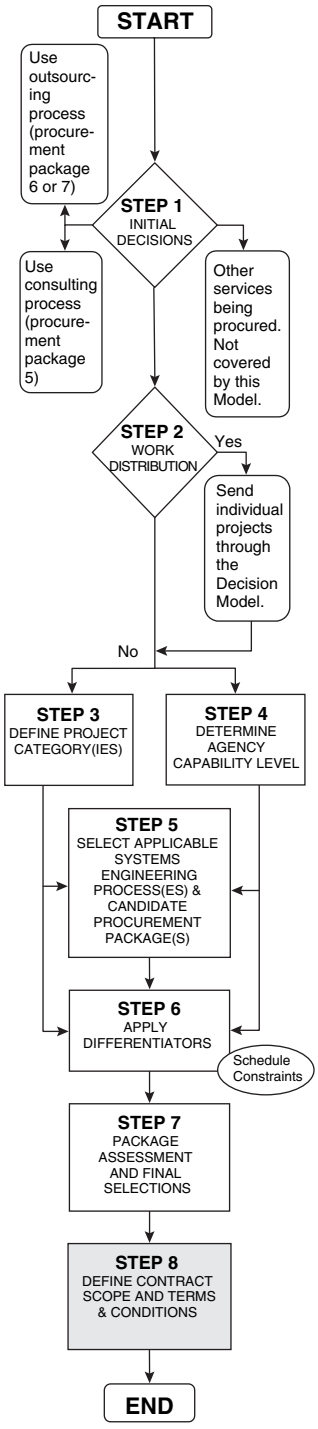


Table 5. Procurement packages and their associated terms and conditions.

Procurement Package	Terms and Conditions	
Commodity Supplier	Contractor Inspection Requirements Inspection of Supplies Option for Increased Quantity Ordering	Definite Quantity Indefinite Quantity Brand Name of Equal Performance/Payment Bond
Low-Bid Contractor with Design Consultant	Design within Funding Limitation Redesign Responsibility for Design Errors or Deficiencies Deficiencies	Fixed Price Incentive Fee Performance/Payment Bond
Systems Manager	Negotiation Commercial Computer Software Restricted Rights Fixed Fee Incentive Fee Rights in Data Allowable Costs and Payment Performance-Based Payments Delivery Orders (Task Orders)	Specifications Delays and Extensions of Time Modifications Delivery and Acceptance Conflicting Terms Patent Infringement Indemnification Federal Grant Flow-Down Provisions Performance/Payment Bond
Design-Build Contractor with Design Consultant	Negotiation Design within Funding Limitations Redesign Responsibility for Design Errors Work Oversight Suspension of Work	Fixed Fee Incentive Fee Execution and Commencement of Work Performance/Payment Bond Specifications and Drawings
Consultant	Negotiation Notice of Cost Comparison Allowable Costs and Payment Fixed Fee Incentive Fee Performance-Based Payments Deliver Orders (Task Orders)	Specifications Delays and Extensions of Time Modifications Delivery and Acceptance Disputes Retention of Records Indemnification
Outsourcing Agency Activity	Negotiation Fixed Fee Incentive Fee Work Oversight Execution and Commencement of Work	Performance/Payment Bond Allowable Costs and Payment Performance-Based Payments Modifications Rights in Data
Outsourcing Agency Function	Negotiation Fixed Fee Incentive Fee Work Oversight Execution and Commencement of Work	Performance/Payment Bond Allowable Costs and Payment Modifications Rights in Data

Contract Terms and Conditions Definitions

The following list defines general contract terms and conditions and those associated with the seven types of procurement packages listed in Table 5:

Agency-Furnished Property	Describes how agency property will be delivered to a contractor for use during the term of the contract.
Allowable Costs and Payment	Identifies all contractor costs that will be allowable under the contract and the process of payment for those costs.
Anti-Bribery	Requires the contractor to affirm that none of its officers, directors, partners, or employees has been convicted of bribery under the laws of any state or the federal government.
Assignment of Claims	Allows the contractor the right to assign its rights to be paid to a bank, trust company, or any other financing institution.
Bid Guarantee	Protects the agency in the event bidders do not provide an acceptable bid guarantee as required at the time of bid submission.
Bid Samples (Sealed Bidding Only)	Insures the contractor provides bid samples, in the quantities, sizes, etc., required for the items identified in the bid and must be submitted and received before or at the time for opening the bids.
Brand Name of Equal	Requires the contractor to provide the brand name product or one that will be equal in all material respects.
Commercial Computer Software-Restricted Rights	Describes the specific restricted rights for contracts computer software of the agency and contractor.
Commercial Warranty	Insures the contractor agrees to provide the most favorable commercial warranties the contractor gives to any of its customers for supplies or services.
Compensation and Method of Payment	Identifies the terms of compensation and the method of payments the agency will pay to the contractor.
Compliance with Laws	Requires the contractor to be in compliance with all laws (federal, state, local etc.) To qualify for award of a contract.
Conflicting Terms	Protects the agency from any terms the contractor may attempt to add to the contract with the agency terms taking precedence.

Contingent Fee Prohibition	Allows the agency to terminate a contract if the contractor is found to have employed or retained to solicit a contract a bona fide employee of agency.
Contingent Fees	Protects the agency from any commission, percentage, brokerage, or other fee that is contingent on the success that a person or firm has in securing a contract with the agency.
Contract Affidavit	Affirms that the contractor is indeed a recognized business entity, either domestic or foreign, and the individual signing the contract is duly authorized to do so by the business.
Contractor Inspection Requirements	Requires the contractor to be responsible for performing all inspections and tests necessary to insure conformance with contract requirements.
Contractor's Invoices	Describes what the agency requires from the contractor on all its invoices for payment purposes.
Cost and Price Certification	Requires the contractor to certify that their cost or price information is accurate and complete.
Definite Quantity	Used when exact numbers of the requirements are known and can often protect the agency from paying more for known quantities.
Delays and Extensions of Time	Describes the process and protects the agency in the event delays and/or extensions of time are encountered or requested by the contractor.
Delivery and Acceptance	Describes the delivery and acceptance process with which the contractor must comply.
Delivery of Supplies F.O.B. Destination	Insures the agency is free of expense and the contractor will be responsible for all costs associated with delivery of supplies and or materials.
Delivery Orders (Task Orders)	Describes the process the agency will use to order specific work under the contact.
Descriptive Literature (Sealed Bidding Only)	Requires the bidder to furnish literature that shows the item(s) in the bid for which it pertains by the time specified in the bid for receipt.
Design within Funding Limitation	Requires the contractor to design the requirement within a not-to-exceed amount of funding available for the project.
Discount for Prompt Payment	Provides for the agency to receive a percentage discount for payments made to the contractor normally within a certain number of days from the submittal of an invoice to the agency from the contractor.
Disputes	Defines the parties to the contracts rights in the event of any disputes associated with the contract.
Equal Low Bids	Provides for the agency to award a contract when there is economic benefit that is in its best interest (in-state versus out-of-state contractor).

Execution and Commencement of Work	Requires the contractor to sign and return the contract document by a specific date and also to proceed with the performance of the work, including the purchase of necessary materials as required by the contract.
Extras	Prevents the contractor from receiving payment for extras unless such extras are authorized in writing by the agency contracting official.
Federal Grant Flow-Down Provisions	Identifies the federal contract terms and conditions (clauses) that must be used in agency contracts when using federal grant funds.
Federal, State, Local Taxes	Assures the contractor warrants that no federal, state, or local taxes have been included (excise taxes) in the amounts quoted in the bid or proposal.
Financial Disclosure	Requires the contractor to file specific information to include disclosure of beneficial ownership of business interests.
Fixed Fee	Provides the contractor with a predetermined amount of fee to be paid by the agency assuming the contractor satisfactorily completes the requirements under contract.
Fixed Price	Provides for the agency to assume the least financial risk and places the most risk on the contractor.
Gratuities	Insures the agency's right to terminate a contract in the event the contractor offers or gives a gratuity to any officer, official or employee of the agency.
Incentive Fee	Provides for the contractor to receive additional compensation providing it exceeds the agency's requirements.
Incorporation by Reference	Protects the agency by stating that all terms and conditions of the contract and any changes are made a part of the contract.
Indefinite Quantity	Used when the exact numbers of the requirements are not known and can cost the agency more as more risk is placed on the contractor.
Indemnification	Protects the agency from any obligation to indemnify, hold harmless, or pay attorney's fees that result from the contract.
Independent Pricing	Insures the contractor's offer has been arrived at independently without attempting to limit full and open competition.
Inspection of Supplies	Requires the contractor to maintain an inspection system that is acceptable to the agency.
Insurance	Defines the types and amounts of insurance coverage the contractor shall provide to perform any work under a contract.
Intellectual Property	Indemnifies the agency with respect to any claim, cost or action for patent infringement or trademark or copyright violation as a result of the contract.
Late Bids, Modifications, or Withdrawals of Bids	Describes the process by which late bids, modifications, or withdrawals of bids from the contractor will or will not be accepted by the agency.

Liquidated Damages	Provides for the agency to receive from the contractor compensation in the event the contractor fails to perform in accordance with the contract.
Modifications	Describes the process by and for which modifications will be executed under the contract.
Multiple Contract Awards	Allows the agency to award more than one contract if multiple awards are in the best interests of the agency.
Multi-Year Contracts Contingent Upon Appropriations	Protects the agency for long-term contracts in the event that the funding authority does not make future-year fiscal appropriations.
Negotiation	Identifies the agency's process for a negotiated procurement.
Nondiscrimination in Employment	Insures the contractor will not discriminate against any race when employing individuals to perform work under the contract.
Non-Hiring of Employees	Prevents the contractor from hiring agency employees during the contract term and sometimes vice versa.
Notice of Cost Comparison	Puts all contractors on notice of the agency's intent to perform cost comparisons of proposals before award of a contract.
Officials Not to Benefit	Protects against agency officials sharing or benefiting in any way from a contract.
Option for Increased Quantity	Allows the agency to increase the quantities of supplies called for in the contract at the contract bid price.
Order of Precedence	Describes the order in which each part of the contract will govern and generally protects the agency more in the event of contract disputes.
Ordering	Describes how the agency will order supplies or services from the contractor under the contract.
Parties to the Contract	Identifies and defines all legal entities to the contract.
Patent Infringement Indemnification	Describes how the contractor indemnifies the agency for infringement of agency patent.
Patent Rights	Protects the agency against any claims made against them for any alleged infringements of patents by the contractor or other third parties.
Payments Under Transportation Contracts	Describes how the contractor will be paid by the agency for transportation or transportation-related services.
Performance-Based Payments	Describes how the agency will make payments to the contractor based strictly on performance of specific requirements (normally specific deliverables) under the contract.
Performance/Payment Bond	Requires the contractor to purchase a bond equal to 100% of the total contract value, which insures the contractor will perform all the work and/or pay all their subcontractors; otherwise, the agency can call in the bond to insure the work will be performed even if it is by other contractors.

Political Contribution Disclosure	Requires the contractor to file specific information for political contributions made for elective office in any primary general election.
Pre-Existing Regulations	Protects the agency in the event there may be other regulations to consider that may take precedence over the specific terms and conditions within a contract.
Redesign Responsibility for Design Errors or Deficiencies	Requires the contractor to redesign the requirement at no cost to the agency in those cases where the contractor has errors, deficiencies, or inadequacies in the design.
Retention of Records	Requires the contractor to maintain all records pertaining to a contract for a specific period of time.
Rights in Data	Describes the agency's and contractor's rights for data, including source code ownership and use, and identifies the specific types of data under the contract.
Scope of the Contract	Describes in as much detail as possible what the agency is soliciting and expects to receive from the contractor and becomes a part of the contract at time of contract award.
Specifications	Requires the contractor to ensure that all materials, equipment, supplies, or services conform to federal and state laws and regulations and to the specifications contained in the contract.
State Law Prevails	Protects the agency in the event of contract disputes in that their own state laws will be used to litigate those disputes.
Suspension of Work	Allows the agency to suspend the contractor's work if it is in the best interests of the agency.
Tax Exemption	Protects the agency from paying any taxes borne by the contractor under the contract.
Termination for Convenience	Allows the agency to terminate a contract at any time for its convenience with minimal financial risk to the agency.
Termination for Default	Protects the agency in the event of contractor non-performance and results in early termination of a contract due to actions or inactions solely by the contractor.
Truth-In-Negotiation Certification	Requires the contractor to certify that their wage rates and other factual unit costs are current and accurate at the time of contract award.
Unnecessary Elaborate Contractor Proposals	Informs the contractor that elaborate proposals are not desired and may be an indication of the contractor's lack of cost consciousness.
Variations in Estimated Quantities	Protects the agency when it becomes necessary for the agency to order more or less work under the contract.
Work Oversight	Allows for general oversight, supervision, direction, and approval by the agency over the contractor for prosecution of the work under the contract.

APPENDIX A

Determining ITS Project Category (Complexity and Risk)

[Step 3 Worksheet]

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 based on COTS software and hardware 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 multiple-phase 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 two or three). May be single stand-alone project, or may be part of multiple-phase 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 be implemented. 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 known but includes one or more interfaces to new and/or 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 into 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 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 B

Determining Agency Capability Level

[Step 4 Worksheet]

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 not defined. Responsibility housed within organization with other mission or primary responsibility. Responsibility may also be scattered among organizational entities with no clear lines of responsibility.
2. 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 among these units. An umbrella ITS organizational unit may exist, but may not have the budgetary authority to effectively manage subunits.
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 existing budget of organizational unit(s).
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 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 whether they have 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 Capability Score (Answer Number Total): [ ]

Agency Capability 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 ranges your agency capability 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 capability 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.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation