

DRAFT REQUEST FOR PROPOSALS
For Discussion at June 5, 2008 Pre-RFP Conference



DRAFT REQUEST FOR PROPOSALS

Focus Area: Reliability

Project Number: L02

Project Title: Establishing Monitoring Programs for Travel Time Reliability

Date Posted: July 29, 2008

SHRP 2 Background

To address the challenges of moving people and goods efficiently and safely on the nation's highways, Congress has created the second Strategic Highway Research Program (SHRP 2). SHRP 2 is a targeted, short-term research program carried out through competitively awarded contracts to qualified researchers in the academic, private, and public sectors. SHRP 2 addresses four strategic focus areas: the role of human behavior in highway safety (Safety); rapid highway renewal (Renewal); congestion reduction through improved travel time reliability (Reliability); and transportation planning that better integrates community, economic, and environmental considerations into new highway capacity (Capacity). Under current legislative provisions, SHRP 2 will receive approximately \$150 million with a total program duration of 7 years.

Reliability Focus Area

The overall goal of the SHRP 2 Reliability program is to reduce congestion through incident reduction, management, response, and mitigation. Achievement of this goal would significantly improve travel time reliability for many types of person and freight trips on the nation's highways.

Travel time reliability refers to how travel time varies over time and the impacts of this variance on highway users. In other words, for repeated travel or vehicles making similar trips, there is an underlying distribution of travel time for a particular type of trip within a specific time period between two points. Individual travelers respond differently to the factors and uncertainties associated with the travel time. So do those involved in freight transportation. For important trips such as a trip to the doctor or a just-in-time freight delivery, the driver (or possibly the freight dispatcher) will build extra time into the trip to ensure arrival within a time window with a high probability, for example 19 out of 20 times (=95% of the time). A considerable literature is evolving regarding performance measures of travel time reliability. For example, see the resources on travel time reliability available at the Federal Highway Administration's Operations website: http://www.ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm#Whatmeasures

According to previous research, seven major factors account for approximately half of all traffic delay, and therefore, a great deal of the uncertainty associated with travel time: (1) traffic incidents, (2) work zones, (3) weather (4) special events, (5) traffic control

devices, (6) fluctuations in demand, and (7) inadequate base capacity. These factors do not always affect travel time reliability separately. They often interact, which increases the challenge of reducing the uncertainty of travel time that drivers experience.

Project Background

Traffic on the highway network has been monitored for many decades. As a condition of receiving federal aid for highways, every state must have a traffic monitoring program. Most statewide traffic monitoring programs have relied on automatic traffic recorders (ATRs) installed at roadway locations determined by a sampling plan and other considerations. Most ATRs use inductive loops to continuously or periodically collect traffic volume data. Inductive loops are sometimes combined with piezoelectric or weigh-in-motion sensors to obtain speed, lane occupancy, and vehicle classification data. The data are sent to an organizational unit in the state transportation agency where they are stored, checked, and converted to various types of information such as average annual daily traffic estimates. An important use of data collected at ATR sites is to impute traffic volumes on links of the network where no traffic monitoring unit exists. Temporary counts help in this process.

Typically, ATR data are not made available for use in real-time, although some ATR stations could potentially be converted into sources of real-time data. Frequently ATR data are stored in the field equipment before being downloaded manually or via a dial-up modem. Therefore, the use of ATR data for real-time operations is limited. ATR data are already being used in some places for characterizing travel time reliability on the roadway segments with ATRs, but, no *programs* are in place to systematically report, on a periodic basis, the reliability of service offered by the transportation network for people and goods in various parts of a metropolitan area or state as a regular input to the operational planning, programming, and decision-making processes in those areas.

A large number of data collection technologies are currently in use in the United States, including but not limited to: inductive loops, closed circuit television (CCTV) with pattern recognition (e.g. license plate readers), inductive signature identification, toll tag readers, embedded wireless magnetometers, microwave radar, electromagnetic detectors, Global Positioning System (GPS) receivers, cellular telephones, and other radio-based technologies. Not every detector technology provides speed and travel time determination capabilities. The selection and deployment of specific technologies requires a system engineering process; the appropriate technology varies depending upon climate, roadway type, the physical characteristics of the roadway network, budget, and other factors. The diversity of technologies and operational environments will be an important consideration in this project.

Substantial information already exists regarding the design and implementation of traffic monitoring systems for both real-time applications (e.g. freeway traffic management) and statewide travel monitoring programs. One of the key issues for this research is adaptability of these systems to gather current information on travel time reliability for real-time operations management and for post hoc use of archived (historical) data, possibly augmented by special data collection programs, in other levels of decision making.

Primary guidance on the design and implementation of traffic monitoring systems comes from the National and Regional ITS Architectures, many studies and handbooks on traffic monitoring systems, and the accumulated experience of individuals in the public and private sectors. The communications taxonomy developed for ITS communications standards (e.g. Traffic Operations Center to Field (e.g. traffic sensors), Field to Center, Field to Field, and Center to Center) is relevant to this project. So are the National Transportation Communications for Intelligent Transportation Systems Protocols (NTCIP), a set of standards to promote open systems and interoperability of equipment such as traffic detectors (Federal aid cannot be spent on ITS systems if data interchange is not compliant with the NTCIP). Section 1201 of SAFETEA-LU called on every state to develop a system of basic real-time information for operating and managing the highway network. Section 1201 called for the development of a data exchange format for real-time monitoring of highways and transit within two years of enactment of SAFETEA-LU (a domain specific version of the Extensible Markup Language (XML) has been an obvious candidate for such a format).

There are other key issues regarding the handling of data useful for improving travel time reliability, whether for real-time operations or other purposes. These include quality control, algorithm development, and protection of privacy. Data storage, back-up, and security are important technical and institutional issues resulting from the very large amount of data accumulated by travel time reliability monitoring systems.

The Archived Data User Service (ADUS) of the ITS National Architecture and regional architectures provide insight on how to design a subsystem of the traffic monitoring system that can accumulate historical data that can be used to perform analysis, develop models, and serve planning, programming, and other levels of decision making besides real-time systems operations and management. Considerable additional published work addresses how to build an effective ADUS.

As mentioned in the previous section, among the seven primary factors that affect travel time reliability are incidents, weather, work zones, and variations in demand. Combining travel time data with data on the other (explanatory) variables is important in the design of a reliability monitoring system.

The design of a travel time reliability monitoring system requires the use of statistics to develop a sampling plan for locating traffic detectors and collecting travel time data—this includes determining appropriate geographic and time scales. Statistical methods also provide insight regarding the selection, validation, and application of appropriate measures of travel time reliability, as well as for estimating models of travel time reliability that reflect key factors such as weather. Other issues include how to impute travel time data collected to adjacent segments or to nearby links and how to aggregate data from specific locations and events to higher levels such as corridors, regions, or even an entire state. Finally, a key focus in travel time reliability from the road user perspective (demand side) is the net effect on a user's trip through the network, i.e. on

travel from origin to destination. Therefore, an exclusive focus on freeway segments is insufficient to meet this critical aspect of a travel time reliability monitoring program.

In summary, traffic monitoring systems are needed that can produce data on the variability (reliability) of travel time for passenger and freight movement, for different trip purposes, peak and off-peak periods, and in different geographic and climatic settings with fundamentally different types of highway networks. This information is necessary for real-time operations management of the highway system—to reduce the uncertainty of travel time, reduce congestion, and improve mobility in general. Also, archived travel time data, when transformed into travel time reliability measures, is valuable for planning, programming, and other purposes. Furthermore, related data on incidents, weather, and so on help explain the uncertainty associated with travel time and are critical for many types of travel time reliability analysis and model development.

Objective

The objective of this project is to develop alternative system designs for programs to monitor travel time reliability and to prepare a guidebook that practitioners and others can use to design, build, operate, and maintain such systems. Although traffic detectors acquire data for many purposes including mobility monitoring, operations, security, pavement design, and safety analysis, the focus of this project is on travel time reliability (See Note 1 for further clarification). The data from the monitoring system(s) – from public and private sources – should include, wherever cost-effective, information on the seven sources of non-recurring congestion. Data from the travel time reliability monitoring system(s) can then be used to construct performance measures or perform various types of analysis useful for real time operations management as well as policy, planning and programming, especially exploring tradeoffs between capital and operations expenditures. The guidebook should be more than just a compilation of existing processes and technologies, and it should address not just freeways but other types of roads such as tollways and urban arterials.

Phase I – System Design Needs -- Define User and Functional Requirements for Travel Time Reliability Monitoring Systems

Task 1: Review and document the state of the practice concerning the full range of traffic monitoring systems used in the public and private sector. This task should include a review of the ways reliability data is currently being collected by transportation agencies/operators, how such information is being disseminated to roadway system users, and how such information is being used for operational, tactical, and strategic decisionmaking (or why this is not occurring). Include a literature review and other interactive ways (e.g. interviews) to gather information from those knowledgeable about the systems. This task shall produce a summary of advantages and disadvantages of existing systems, lessons learned, institutional issues, technical issues, and gaps. Include information available from other SHRP 2 Reliability projects (See Note 2).

Task 2: Identify user needs (public sector, private sector, road users) that are to be met through a reliability monitoring program. Address user needs both with respect to real-time systems operations and management and for such activities as policy, planning,

programming and budgeting. This task should identify opportunities at the operational, tactical, and strategic levels for enhanced reliability information to improve agency and private-sector decisionmaking, guide resource allocation, and more efficiently use the roadway system.

Task 3: Characterize user needs identified in Task 2 with respect to the full range of operating, technical, and data environments along the dimensions listed below. Identify at least five combinations that are most representative of the typical environments encountered on roadways in the United States. (For example, one of these environments might be two-lane rural highway with little or no equipment for collecting real-time data). Also identify any less common operational scenarios that merit special consideration.

Access controlled corridors (e.g. freeways)	Corridors without access control (e.g. signalized arterials)
Urban	Rural
Data collection by segment	Data collection for origins and destinations
Road-based data collection	Vehicle-based data collection
Legacy monitoring systems	New monitoring systems (in new locations and/or using new technology)
Real-time data	Archived data
Person travel	Freight Travel
Public systems	Private systems and systems that are public/private partnerships

Task 4: Define Functional Requirements. The contractor must fully specify the functional requirements for both a real-time and archival travel time reliability monitoring system(s). Functional requirements include but are not limited to the following:

- Builds on existing (legacy) and emerging detection technology and monitoring systems. Focuses on data and performance measures relevant to travel time reliability while recognizing broader or different objectives of existing traffic monitoring systems such as mobility and asset management.
- Provides a means to communicate data and performance regarding travel time reliability collected from traffic detectors at specific locations to various users of the monitoring system(s).
- Uses public and private sources of data as appropriate.
- Serves traffic monitoring needs of the public and private sectors.
- Stores travel time and other data concerning reliability (e.g. data on the seven sources of non-recurring congestion) in a data base in accordance with a metadata standard.
- Provides for data transfer into the system and dissemination to users from the system.
- Uses appropriate telecommunications.

- Leverages the efforts underway at FHWA regarding SAFETEA-LU Section 1201 that are aimed at developing a real-time information management structure for the National Highway System and other major arterials in metropolitan areas as well as transit systems.
- Addresses freight and person trips.
- Supports computation and estimation of travel time reliability measures, including measures for individual roadway segments, roadway corridors, and key origin-destination pairs.
- Supports the compilation of data suitable for development, testing, and refinement of travel time reliability prediction algorithms for both real time and static (e.g. planning) applications.
- Provides a means to impute travel time and travel time reliability information and performance measures to where traffic data is not available
- Supports aggregation of localized travel time reliability to corridors, subsystems, and systems.
- Provides a foundation for agencies/operators to monitor long- and short-term changes in the reliability performance of their roadway systems, and possibly compare them with peers.
- Provides a means for real-time monitoring of equipment malfunction.

Task 5: Obtain buy-in on user and functional requirements. The proposer should consider the most effective methods and ways of involving stakeholders in the five or more operating, technical and data environments identified in Task 2.

Task 6: Prepare the Phase I Report. Thoroughly document the work performed under Tasks 1 through 5. Submit a Draft Phase I Report for review. Within 30 days SHRP 2 will provide comments. Prepare a Final Phase I report that responds to the comments of SHRP 2. The contractor may not proceed with work on Phase II without approval of SHRP 2.

Phase II – System Design Completion and Guidebook Preparation

In this phase, the contractor will complete the system design and develop a guidebook describing the structure and possible components of a travel time reliability measurement system that meets the functional requirements and addresses the five most representative scenarios identified in Phase I.

Task 7: Develop travel time sampling and data acquisition plans, including how to fill gaps and aggregate to higher level networks, for:

- (a) Real-time operations
- (b) Archival and/or special-purpose data useful for planning, programming, prediction modeling, performance measurement, and similar purposes

Task 8: Develop a plan for acquiring the data necessary to account for the seven sources of travel time variability that affect the travel time data collected in Task 7 (i.e. linking the data in time and space).

Task 9: Design monitoring systems that provide the ability to calculate performance measures related to travel time reliability and account for the seven sources that influence travel time reliability and the five or more operating, technical, and data environments identified in Task 2 for both of the following:

- (a) Real-time operations
- (b) Uses of archival data

Task 10: Assess the design tradeoffs for both real-time versus archived travel time data collection systems. At a minimum, consider operations management, economic (including lifecycle costs), technical, analytical, and institutional factors as well as the ability to satisfy functional requirements. Consider the methods and implications of converting sources of archived data (e.g. from Automated Traffic Recorders) to real-time data. Address issues related to computation or imputation of data for environments where the density of data collection devices is low. Address equipment reliability issues.

Task 11: Prepare a Draft Phase II Report that fully documents the results of Tasks 7 through 10. The Draft Phase II documents the completion of the design work and must also include a detailed work plan, budget and schedule for Phase III. Also, prepare and submit to SHRP 2 a Draft Unvalidated Guidebook on Monitoring System(s) for Travel Time Reliability. Within 30 days of receipt of the Draft Phase II Report and the Draft Unvalidated Guidebook SHRP 2 will provide comments to the contractor. Prepare Submit the Final Phase II Report and the Final Unvalidated Guidebook within 60 days of receipt of the SHRP 2 comments. Work on Phase III may not proceed without approval of SHRP 2.

Phase III – Validate Monitoring Programs

The contractor shall validate the procedures developed in the guidebook. At a minimum, the contractor shall demonstrate and/or validate the establishment of a travel time reliability monitoring system for the following types of areas:

- Areas where no data are currently being collected
- Areas where there are some existing sources of travel time and other relevant data but the travel time data, in particular, are not fully representative of the highway network, sub-network, or corridor
- Areas where high density of travel time data collection is occurring, and selected additional relevant data is available (See Note 3)

The contractor shall report on implementation issues: technical, analytical, economic, and institutional. Validate the monitoring program(s) using computer simulation and/or field tests. Where field tests are conducted, assess the degree to which the monitoring program(s) provide information that accurately reflects field conditions, and particularly travel times.

The proposer is being offered substantial flexibility regarding how to approach Phase III. The proposer should tailor the scope and focus of the travel time reliability monitoring

system to be implemented and its validation to the proposer's budget for Phase III (see Funds Available, below).

Some possible activities and areas of focus the contractor may consider in the validation phase are:

- Using GPS and cell phone technology
- Using an ad hoc mobile network that communicates travel time/speed and reliability data from in-vehicle navigation devices to all other vehicles with the same or similar type of equipment
- Converting ATRs so they provide real-time and archival data
- Using data loggers, controllers, or equivalent NTCIP software
- Combining data concerning travel time data and travel time distributions with interaction effects concerning the seven factors that influence non-recurring congestion.

Prepare and submit to SHRP 2 a Draft Validated Guidebook on Monitoring System(s) for Travel Time Reliability and a Draft Phase III Report that fully documents the work performed under Phase III. SHRP 2 will provide comments on the Draft Validated Guidebook and the Draft Phase III report within 30 days of receipt of these deliverables. Prepare a Final Validated Guidebook report that responds to the SHRP 2 comments. Submit the Final Validated Guidebook and the Final Phase III Report within 60 days of receipt of the SHRP 2 comments.

Deliverables

- Phase I Draft Report
- Phase I Final Report
- Phase II Draft Report
- Phase II Draft Unvalidated Guidebook
- Phase II Final Report
- Phase II Final Unvalidated Guidebook
- Phase III Draft Validated Guidebook
- Phase III Draft Report
- Phase III Final Validated Guidebook
- Phase III Final Report
- Three meetings with SHRP 2 staff: Two (2) in Washington, DC and the one (1) at the contractor's facility
- Semi-annual meetings with the Reliability Technical Coordinating Committee in Washington DC; Irvine, CA; or Woods Hole, MA.
- Semi-annual SHRP 2 Reliability contractor coordination meetings at locations to be

determined

- Telephone conference calls, as needed

Funds Available

Not to exceed \$1.8 million for the entire project. A potential contractor may propose any budget allocation by phase in order to most effectively achieve the project objectives and fully take advantage of the expertise of its team. A possible allocation is Phase I: \$150,000; Phase II: \$350,000; Phase III: \$1.3M.

Contract Period: Not to exceed thirty-six months (36) months for the entire project. Phases I & 2 are to be completed in 18 months.

Responsible Staff: William Hyman, whyman@nas.edu, 202-334-1914

Authorization to Begin Work: November 2008, anticipated

Proposals (20 single-bound copies) are due not later than 4:30 p.m. Eastern Standard Time (EST) on September 15, 2008

This is a firm deadline, and extensions simply are not granted. In order to be considered, all 20 copies of the agency's proposal accompanied by the executed, unmodified Liability Statement must be in our offices not later than the deadline shown, or they will be rejected.

Delivery Address:

PROPOSAL-SHRP 2
ATTN: Neil F. Hawks
Director, Strategic Highway Research Program 2
Transportation Research Board
500 Fifth Street, NW
Washington, DC 20001

Phone: 202-334-1430

Liability Statement

The signature of an authorized representative of the proposing agency is required on the unaltered statement in order for SHRP 2 to accept the agency's proposal for consideration. **Proposals submitted without this executed and unaltered statement by the proposal deadline will be summarily rejected.** An executed, unaltered statement indicates the agency's intent and ability to execute a contract that includes the provisions in the statement. Here is a printable version of the [Liability Statement \(pdf\)](#). A free copy

General Notes

1. According to the provisions of Title 49, Code of Federal Regulations, Part 21, which relates to nondiscrimination in federally assisted programs, all parties are hereby notified that the contract entered into pursuant to this announcement will be awarded without discrimination on the grounds of race, color, religion, sex, national origin, or disability.
2. The essential features required in a proposal for research are detailed in the brochure entitled [*A Manual for Conducting Research and Preparing Proposals for SHRP 2.*](#) Proposals must be prepared according to this document, and attention is directed specifically to Section IV for mandatory requirements. Proposals that do not conform with these requirements will be rejected.
3. The total funds available are made known in the project statement, and line items of the budget are examined to determine the reasonableness of the allocation of funds to the various tasks. If the proposed total cost exceeds the funds available, the proposal is rejected.
4. All proposals become the property of the Transportation Research Board. Final disposition will be made according to the policies thereof, including the right to reject all proposals.
5. Proposals will be evaluated by SHRP 2 staff and Expert Task Groups (ETGs) consisting of individuals collectively very knowledgeable in the problem area. Selection of an agency is made by the SHRP 2 Oversight Committee, based on the recommendation from SHRP 2 staff and the ETG. The following factors are considered: (1) the proposer's demonstrated understanding of the problem; (2) the merit of the proposed research approach and experimental design; (3) the experience, qualifications, and objectivity of the research team in the same or closely related problem area; (4) the proposer's plan for participation by disadvantaged business enterprises—small firms owned and controlled by minorities or women; and (5) the adequacy of facilities.
6. Any clarifications regarding this RFP will be posted on the SHRP 2 Web site at (www.trb.org/shrp2). Announcements of such clarifications will be posted on the front page and, when possible, will be noted in the TRB e-newsletter. Proposers are advised to check the Web site frequently until September 11, 2008, when no further comments will be posted.
7. A bidder's proposal is required set out a management plan and a plan for quality control/quality assurance (QC/QA). The management plan should identify a person responsible for overall performance of the project, typically an officer of the prime contractor, and who has the authority to take corrective action; an organizational structure of the team with a description of the organizing principles; where and in what manner the key staff and experts will be applied to functions or tasks of the project; how coordination

of subcontractors and sub-consultants will be achieved; management of resources (budget, labor, equipment); and schedule adherence. The QC/QA plan should address how quality will be built in as the tasks are being executed and describe the oversight necessary to assure the quality of the products of the tasks and phases once they are largely complete.

IMPORTANT NOTICE

Potential proposers should understand that the research project described herein is tentative. The final content of the program depends on the level of funding made available. Nevertheless, to be prepared to execute research contracts as soon as possible after sponsors' approvals, the Strategic Highway Research Program is assuming that the tentative program will become official in its entirety and is proceeding with requests for proposals and selections of research agencies.

Special Notes

Note 1: This project is focused on monitoring systems to address travel time reliability and non-recurring congestion. However, it is recognized that the monitoring systems will be applicable to monitoring travel time reliability of both non-recurring and recurring congestion. Consequently it is important that the monitoring systems be capable of collecting, storing, and disseminating data concerning causes of travel time variability.

Note 2: Work performed under this project should be coordinated with other SHRP 2 projects. Of most importance, is SHRP 2 Project L03: Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies. Project L06: Institutional Architectures to Advance Operational Strategies may be of some relevance. Proposers should bear in mind that work performed under Project L02 is likely to be used as input to and will be coordinated with SHRP 2 Project L04: Incorporating Reliability Estimation into Planning and Operations Modeling Tools; SHRP 2 Project L05: Incorporating Reliability Measures into the Transportation Planning and Programming Process; and SHRP 2 Project L08: Incorporation of Non-Recurrent Congestion Factors into the Highway Capacity Manual Methods.

Note 3: The validation plan must be realistic taking into account the project funds and the portion allocated to Phase III. The three data regimes here can be addressed in a more or less integrated fashion within one or several operating, technical, and data environments defined in Phase I.