

Synthesis of Best Practices for the Development of an Integrated Data and Information Management Approach

**Progress Report
For the Period 9/1/2002 to 4/4/2003
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A. Problem Statement:

State transportation agencies struggle with numerous problems and challenges in building integrated data and information systems that provide high-quality information for the effective execution and management of operations and for supporting analysis, control and decision making activities. The problems are both technical and organizational. Among them are the barriers that departments go through to get new systems up and running. Many departments complain about how hard it is to get the IT shop to respond to changing needs. At the same time, IT shops often feel criticized for enforcing the information strategy plans which may not be updated to reflect changing needs.

Another major problem facing organization is the so-called “information gap”: The organization has “mountains of data” but very little information to support changing business needs and inter-agency collaboration. State transportation agencies are shifting focus away from construction new highways and facilities toward improving operations safety, and performance-based maintenance of existing facilities. Now more than every, state transportation agencies must interface with external organization to address issues concerning environmental sustainability, safety, and most recently, homeland security.

Two reasons for the information gap are the fragmented ways in which organizations have developed information systems and databases, and the fact that most systems have been developed to support routine business processes, with little attention to the information and analytical tools needed for analysis, control, and decision making. Many systems were developed one application at a time, resulting in uncoordinated and often inconsistent databases, using a variety of hardware and software platforms. It is then extremely difficult if not impossible for managers to locate and assemble the relevant information they need, which must be synthesized across these many systems. Among the problems that arise from this practice are:

- Uncontrolled redundancy (duplication)
- Possibility of inconsistency in data; lack of data integrity
- Data/application dependency (data imbedded in the application)
- Limited data sharing; lack of integration; fragmentation
- Lack of uniform standards for data management, security, integrity, location referencing and spatial data quality.
- Low programming productivity; lengthy development time, high maintenance costs

Some agencies aggressively look for new modeling methodologies and information technologies to assist them with data integration. Others do not. Advances in modeling methodologies and in information technologies make it possible to build integrated systems that overcome the information gap problems. They include methodologies for enterprise modeling, advanced database technologies, operational data store and data warehousing technologies, data mining tools, and GIS. These approaches make it possible to centralize data that are scattered throughout disparate operational systems; add value to data by improving their quality and consistency; and eliminate much of the contention for resources that result when informational application are confounded with operational processing. Many agencies have tried information management approaches with varying degrees of success. Some managers are taking the “been there done that” attitude toward the very notion of data integration. This proposal is not meant to convince managers to adopt the strategies but to report to managers the results of our investigation on how and why the various approaches have or have not worked for their peer agencies.

For decades, state DOTs have been collecting and using information about the highway systems based on linear location references. Recent GIS were introduced as a technology to facilitate integration, management, and analysis of data used by DOTs. Subsequently, linear location referencing systems. (LLRS) were developed to manage and maintain linear location reference data in a GIS. They with the introduction of GPS as a convenient data collection tool, strategies for relating geo-referenced data to the

cartographic network were developed. Unfortunately, implementation of GIS for data integration has not been as straightforward as hoped. Furthermore agencies have discovered that GIS is part of the answer but not the entire answer.

Agencies have tried numerous approaches with varying success. These approaches range from continuing to patch standalone isolated systems to designing and developing fully integrated systems that depend on a central data repository, to interoperable systems that communicate through interface “wrappers.” This project aims to identify the underlying success factors and best practices that make the various approaches work and metrics for measuring the relative success of the various approaches. Finally, the project seeks to pull together the success factors, best practices, and performance measures into a coherent set of guidelines as a way for agencies to share the lessons learned.

This project deals with strategies for managing and integrating spatially related transportation data both intra- and inter-agency from the perspective of a state transportation agency. The scope of data is asset management data defined as all data used for making decision regarding the planning, design, construction, operations, and maintenance of transportation facilities.

The results of this research will be presented in the formal Guidelines. The target audience is managers of business functions as well as IT managers.

B. Objectives:

The goal of this research is to bridge the strategies for data integration and build upon previous work to take the next step toward helping state agencies achieve data integration. Specifically the objectives of this research are to

- Develop a working definition of an integrated data and information management approach
- Gather key success factors, best practices, performance measure, and lessons learned regarding information and
- Prepare a set of recommendations and guidelines to help transportation agencies plan, develop, and implement integrated information management systems.

C. Research Plan Progress:

Task 1. Information Gathering

Task 1.1. Literature Review

a. Description: The research team will review literature on:

- Transportation information management and on data integration approaches and technologies.
- Modeling methodologies and information technologies for designing and implementing integrated data and information systems.
- Case studies on implementations in the public and private sectors, including pertinent organizational issues.

b. Percent complete: 40%

c. Progress:

- Literature review using google.com and the GEOBASE database. GEOBASE, developed by Elsevier Science, provides bibliographic references to more than 2,000 primary journals, books, monographs, reports, conference proceedings and theses in fields of human and physical geography, cartography, geographic information systems (GIS), geomorphology, climatology, hydrology and development studies. **Appendix A** lists keywords from the project proposal used for literature review in GEOBASE and google.com search engines.

- Review of printed and on-line proceedings of the Geospatial Information Systems for Transportation (GIS-T) symposium from 1991 through 2002.
- Creation of a draft bibliography (**Appendix B**), from a review of GEOBASE references, google.com links and GIS-T proceedings based on data collection instrument questions.
- Review of IT research, provided by the Gartner Group, readily available to state DOT's on best practices for integrated data and management. **Appendix C** identifies applicable Gartner research documents on IT best practices that were reviewed by the project team.

d. Next steps:

- Literature review using the Transportation Research Board's (TRB) Transportation Research Information Services (TRIS) database.
- Literature review of select information systems and information technologies conferences (i.e., ICIS, HICSS, ICEIS, ICBIS, ICMIC) and journals (i.e., JISR, JAIS, CAIS).
- Literature review using the ABI economics and business journal, magazine and newspaper database.
- Integration of references from MRUTC "Asset Management Literature Review" document.
- Finalization of an annotated bibliography.

Task 1.2. Design Data Collection Instruments

a. Description:

The Research Team will design a data collection instrument that focuses on collecting information about best practices, performance measures and key success factors relating to integration efforts. It will also collect information about specific objectives, information problems, and management issues that motivated the integration efforts, and about methodology IT architecture, and the processes that were employed.

b. Percent complete: 100%

c. Progress:

Appendix D contains the draft data collection instrument four interview/workshops that focus on strategic/organizational, operational, information process/methodology and technology/data quality issues. For each interview/workshop, **Appendix D** presents: targeted attendees, general discussion topics and specific questions.

Task 1.3. Pilot-Test the Data Collection Instruments

a. Description:

The Research Team will use Michigan, Ohio, and Wisconsin as pilot test cases. The Research Team will travel to visit these agencies to collect data as well as to revise and refine the data collection instruments based on the information gathered from the site visits and the recommendations of the agencies. The revised data collection tools will then be used to gather information from the remaining agencies via teleconference interviews.

b. Percent Complete: 95%.

a. Progress:

- Members of the project advisory team from Wisconsin, Ohio and Michigan DOTs provided feedback on the draft data collection instrument.
- The Research Team met face-to-face with Jeff Western (Wisconsin DOT) on 1/23/03 for feedback. A summary of this meeting is provided in **Appendix E**.

- On 2/5/03 a teleconference interview was conducted with Leonard Evans and Shobna Varma (Ohio DOT) for feedback on the data collection instrument. A summary of this meeting is provided in **Appendix F**.
- On 2/13/03 a teleconference interview was conducted with Ron Vibbert (Michigan DOT) for feedback on the draft instrument. A summary of this meeting is provided in **Appendix G**.
- The consensus from all the state DOTs was that many of the questions could be answered through available DOT documents. A memo (**Appendix H**) was distributed to Jeff Western, Leonard Evans, Shobna Varma and Ron Vibbert requesting information as background to prepare for formal interviews.
- Members of the advisory team recommended that the Workshop 4 be eliminated and that aspects of data quality from Workshop 4 be added to workshop 3.
- **Appendix I** contains the revised set of interview questions. Three interviews focus on strategic/organizational, case studies, and information processes/methodology/data quality issues. Appendix I presents general and detailed questions for each workshop. Participants will be asked general questions to provoke discussion. These questions are typically organized by first asking “what systems do they have”, then “what is the purpose of each system” next ask, “why was the system developed”, then ask “how was the system developed” and finally ask “what worked and what didn’t.”

b. Next steps:

- Gather background material requested from state DOTs
- Refine the data collection instrument for each state DOT.
- Identify appropriate case studies and interviewees from each state.

Task 1.4. Collect Data via Teleconference

a. Description:

The research team will identify key contact people from the following state transportation agencies: DE, ID, KS, FL, MO, MN, NY, SD, TX, UT and WA. The Research Team identified these agencies as candidates because the team is aware of enterprise modeling efforts and information strategy planning activities in these agencies. As a result of the literature review, in Task 1.1, other agencies may be identified. The team plans to select and interview up to seven of these agencies.

This task plan will be revised. Rather than interview people from the states listed above, the research team will conduct in-depth face-to-face interviews with the participating states: MI, OH, and WI.

b. Progress: 0% complete.

Task 2. Key Success Factors and Identification of Best Practices

a. Description:

The Research Team will synthesize the data collected in Task 1.4 to identify key success factors and best practices for building integrated systems. The Research Team will identify a manageable set of key success factors and discuss the associated best practices for each. Categories of key success factors and best practices can include links with strategic planning objectives, organizational issues, operation issues, data and enterprise modeling choices, technology choices and specific issues such as location references.

Examples of key success factors and best practices in information systems development include commitment and support of top management; a top-level manager acts as a “champion”; full user involvement, using a problem-solving approach that specifies clear phases and activities; careful planning and analysis of problems; opportunities, and information needs before proceeding to design and

implementation; selecting the proper modeling methodology; establishing standards for consistent development and documentation; periodic review and careful project management.

b. Percent Complete: 50%.

c. Progress:

As suggested by Jeff Western (Wisconsin DOT) and confirmed by Ohio and Michigan DOT's, concepts for best practices on information technology and information systems are available from IT research organizations such as the Gartner Group, Gideon/Gartner (GIGA) and META. The project team has reviewed applicable research documents from Gartner (list in Appendix C). The best practices will be used as a basis for organizing the final project report.

d. Next steps:

- Pick issues from Gartner best practices applicable to state DOTs and project.
- Synthesize data collected in Task 1.4 in the context of Gartner's best practices and key success factors.
- Generate and discuss list of key success factors and related best practices on building integrated systems.
- Frame final report in the context of Gartner's best practices, i.e., identify how state DOTs are using recommended best practices by research organizations like Gartner, what works and what doesn't.

Task 3. Identification of Performance Measures

a. Description:

This task involves identifying specific performance measures that an agency can employ in the integration efforts and the metrics to quantify them. They performance measures should be directly linked to the key success factors identified in Task2. More specifically, the team will identify measures relating to effectiveness and success during the system planning, analysis, design, and implementation phases, as well as measures for assessing the performance of the integrated systems vis-a-vis its added business value as it relates to supporting business analysis and decision making, the quality of the data (accuracy, consistency, timeliness, etc.), and for enhancing accountability.

Some of the performance measures are universal. The research team, however, will analyze the collected data to identify performance measures that are specific and germane to transportation information management. These measures will be organized to allow agency managers to perform self-assessment, among other things.

b. Progress: 0% complete.

Task 4. Analyze the Importance of Practices and Factors

a. Description:

This task involves analyzing the relative importance of practices and factors to explain the discrepancies among the agencies in term of the level of success achieved in implementing data integration. This task also includes analysis of tradeoffs between best practices and factors to achieve successful data integration.

The result of this task is a set of lessons learned that can be derived form the case studies and agency experiences.

b. Progress: 0% complete.

Task 5. Development of Guidelines

a. Description:

The Research Team will develop a set of recommendations and guidelines to help transportation agencies plan, develop, and implement integrated information management systems. The guidelines will be based on the analysis of the results of tasks 1-4 and on the expertise and experience of the Research Team. The guidelines will identify and analyze the advantages and disadvantages of alternative methodologies, modeling tools, and implementation technology. They are not intended to be a tutorial on methodologies, modeling paradigms, or implementation technologies, nor advocate a particular methodology or technology.

The areas that these guidelines will address include but are not limited to the following:

- The systems development life cycle (planning, analysis, design, implementation, support)
- Modeling methodologies for the strategic planning phase (enterprise modeling of business functions and data bases, e.g., on the Information Engineering Framework)
- Determining the information required to support operational, analysis, and decision-making activities
- Location referencing system issues
- Project management and control; managing development teams
- Managing user expectations
- Organizational impacts of the system
- How to select modeling methodologies and information architecture based on objectives
- Should operational systems be separated from informational and decision-making systems?
- Possible information technologies for data integration (operational data store, data warehousing, dependent or independent data marts, etc.)
- Strategies for data cleaning, reconciliation, and transformation
- Managing transient and periodic, temporal data
- Strategies for design of user interface (querying tools, on-line analytical processing tools)
- Data mining tools.

b. Progress: 0% complete.

D. Time Requirements to Complete Project Research

The project duration is 12 months from September 1, 2002 through August 31, 2003. The following table illustrates the proposed and anticipated schedule for completion of project tasks

Table D.1. Project Timeline

Task		Contract Month September 2002 – August 2003											
		S	O	N	D	J	F	M	A	M	J	J	A
		1	2	3	4	5	6	7	8	9	10	11	12
1.1	Literature review												
	Proposed	■	■										
	Actual		■	■	■	■	■	■	■	■			
1.2	Design data collection instruments												
	Proposed			■									
	Actual			■	■								
1.3	Pilot test data collection instruments												
	Proposed			■	■								
	Actual				■	■	■						
1.4	Collect data via teleconference												
	Proposed					■	■						
	Actual							■	■				
2.	Key success factors and best practices												
	Proposed							■	■	■			
	Actual								■	■	■		
3.	Identification of performance measures												
	Proposed							■	■	■			
	Actual								■	■	■		
4.	Analyze importance of practices/factors												
	Proposed							■	■	■			
	Actual								■	■	■		
5.	Development of guidelines												
	Proposed									■	■	■	
	Actual									■	■	■	

Appendix A: Keywords for GEOBASE and google.com Search Engines

enterprise	systems analysis
enterprise system	systems analysis transportation
enterprise system transportation	systems design
integrated data	systems design transportation
integrated data efforts	data models
integrated data efforts transportation	data models transportation
integrated data practices	data modeling
integrated data transportation	enterprise modeling
integrated technology transportation	systems development
data integration experiences	systems development transportation
best practices	information engineering
best practices data	organizational
state of the art transportation	organizational issues agency
data mining	organizational issues data
data mining experience	decision making
data mining transportation	decision making transportation
data maintenance transportation	decision making transportation tools
DOT transportation	user expectations
data acquisition	data cleaning
data warehousing	data reconciliation

Appendix B: Bibliography

The references listed in the bibliography are grouped by general categories loosely based on the questionnaire. Text color indicates the importance/applicability of the reference to this project. Red text indicates that the reference is indirectly related. Black text indicates that the reference is directly related to asset management, transportation and integrated systems (i.e., NCHRP 20-24(11)). The references on proposed approaches to management system development were placed in the "Business case" category, and reviews of existing systems were placed in the "Best practices" category.

Definitions/Background on Asset Management

Federal Highway Administration. (1999) Asset Management Primer, FHWA-IF-00-010, Washington, D.C., p. 18.

Office of Asset Management. (2001). Data Integration and Data Sharing for Transportation Asset Management. Publication No. FHWA-IF-01-015. Federal Highway Administration, US Department of Transportation, Washington, D.C., 2p.

Business Case (reasons) for integrating data/systems for asset management

Motivation

Incentives

Goals

Federal and state mandates

Long term challenges

Berner, L., Kovalev, A., Rochtchin, A., Bogoyavlenskaya, N., Iliushin, S., Kitaitseva, E. (1995). Integrated Approach to Urban Facilities Maintenance and Alarm Management. Computers, Environment & Urban Systems. Vol. 19, No. 3, pp. 201-206.

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Experiences in asset management

Data integration and interfacing

Systems integration

Execution

ISP

ERP

Metadata/data quality

System evolution

Outcomes

Knudson, J., and Greenwald, T., (1991). Pilot Implementation of a Large Transportation-based GIS. In proceedings of the Geographic Information Systems for Transportation Symposium, Orlando, FL, March 5-8, 1991, pp. 27-58.

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Vitale, J. and Hoyle, M. (1997). Development and Implementation of the Pennsylvania Turnpike's Executive Information Management System. In proceedings of the Geographic Information Systems for Transportation Symposium, Greensboro, NC, March 24-26, 1997, pp. 216-232.

Strategic level planning

Gumb, D. (1983). The Application of Systems Analysis Techniques in the MTA's Five Year Capital Program. ITE Journal. No. 10, pp. 25-28.

Evaluation

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Implementation issues for asset management

Barriers

Sathisan, S., and Morse, D., (1997). Issues Related to the Development of a GIS-based Roadway Infrastructure Management System. In proceedings of the Geographic Information Systems for Transportation Symposium, Greensboro, NC, March 24-26, 1997, pp. 289-300.

Wallace, L., and Wiley, L., (1994). What You Heard Is Not What I Said. In proceedings of the Geographic Information Systems for Transportation Symposium, Norfolk, VA, April 11-13, 1994, pp. 270-282.

Organizational/managerial strategies

Azad, B., (1993). The Management/Organizational Challenges of the "Server-Net" Model of GIS-T as Recommended by the NCHRP 20-27. In proceedings of the Geographic Information Systems for Transportation Symposium, Albuquerque, NM, March 29-31, 1993, pp. 327-342.

Technological strategies for cross-functional systems

Managing data quality

Data sharing, integrating and interfacing

Bischoff, J., and Alexander, T. (1997). Data Warehouse: Practical Advice from the Experts. Prentice Hall, Upper Saddle River, NJ

Hoffer, J., George, J., and Valacich, J., (2002). Modern Systems Analysis and Design, Third Edition. Prentice Hall, Upper Saddle River, NJ

Integrated Manufacturing Technology Initiative. (2000). Section 3: Business Operations, Technologies for Enterprise Integration, Oak Ridge, TN, 30p.

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Zimmerman, R., and Cusker, M., (2001). Bringing Information Technology to Infrastructure: A White Paper for a Research Agenda. In proceedings of ICIS, Arlington, VA, June 25-27, 2001.

Integrating location-based data

Basile, R., TenEyck, T., and Pietropola, A., (1991). GIS in Pennsylvania DOT. In proceedings of the Geographic Information Systems for Transportation Symposium, Orlando, FL, March 5-8, 1991, pp. 315-327.

Cusker, M., Goldschmidt, J., Klebenov, D., Lara, J., and Restrepo, C. (2000). Report on the National Forum on Advanced GIS Applications and Database Needs for Civil Infrastructure Systems. Institute for Civil Infrastructure Systems, New York University, NY, 8p.

Durgin, P. (1995). Issues in GIS-T Strategic Planning. In proceedings of the Geographic Information Systems for Transportation Symposium, Sparks, NV, April 2-5, 1996, pp. 299-308.

Evans, J. (1994). Sharing Spatial Environmental Information Across Agencies, Regions and Scales: Issues and Solutions. In Environmental Information Management and Analysis (Ed. Michener, W.). Taylor & Francis, London, pp. 203-219.

Harrison, F., and Payne, G., (1997). Linking a Legacy Enterprise Database to a GIS. In proceedings of the Geographic Information Systems for Transportation Symposium, Greensboro, NC, March 24-26, 1997, pp. 345-356.

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Ries, T., and Fletcher, D., (1994). Dismantling Communication Barriers to Spatial Data Access. In proceedings of the Geographic Information Systems for Transportation Symposium, Norfolk, VA, April 11-13, 1994, pp. 227-239.

Ries, T. (1995). Integrating Governments for Transportation Purposes Using a Geospatial Framework. In proceedings of the Geographic Information Systems for Transportation Symposium, Sparks, NV, April 2-5, 1996, pp. 230-251.

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Vonderohe, A., Travis, L., and Smith, R., (1992). Preliminary Results from Research on Adaptation of Geographic Information Systems for Transportation. In proceedings of the Geographic Information Systems for Transportation Symposium, Portland, OR, March 2-4, 1992, pp. 9-20.

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Project prioritization

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Organizational/managerial/system development processes (IT/ISP framework)

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Appendix C: Relevant Gartner Research Documents

Note Number	Title
AV-18-7198	Government Topics and Key Issues for 2003
K-18-5518	Government Management and Organization
K-18-5937	Government Processes
K-18-5417	Government Infrastructure and Applications
CS-18-2219	Pennsylvania: Creating an Enterprise Application
AV-19-0737	IT Governance In Transition
SPA-19-0306	U.S. State Technology Management Assessment
COM-19-0305	State Technology Management Assessment Criteria
SPA-19-0248	Government's Hierarchy of Challenges
DF-17-4636	Government IT Responsibility: Enterprise vs Agency
ITSV-WW-DP-0318	State and Local Government: A Peek at 2002
AV-15-5519	Real-World Lessons for Systematic Application Integration
COM-16-2732	Government Insights: Tackling Data Integration Challenges
T-15-5501	Strategies for Managing Application Integration Metadata
TG-15-1933	Best Practices: Managing Application Integration Metadata
T-15-1932	Tools and Sources for Application Integration Metadata
TU-15-1931	Identifying Useful Kinds of Application Integration Metadata
DF-14-5561	Managing Multiplying Messages
COM-17-1087	Implementing ERP in Government: A Seminar Discussion
AV-17-2203	Successful Government Initiatives
COM-17-0439	Geospatial One-Stop: Great Project, Not Enough Oversight
COM-16-9493	Achieving the National Spatial Data Infrastructure's Vision
R-18-5757	U.S. Public-Sector GIS Survey: Key Issues and Trends
COM-18-8297	Predictions: Government Geospatial Systems Management

Appendix D: Pilot Data Collection Instrument

Four focused interviews are proposed to identify current IS practices at state DOTs. The focus groups with attendees are presented in Table 1. Discussion topics and potential questions for each group are listed.

1. Strategic and Organizational Level
Attendees: Top executives, policy, planning and IT executives
2. Operational Level
Attendees: Bureau/system chiefs and managers
3. Information Processes and Methodology Level
Attendees: IT executives and managers, analysts and designers
4. Technology Level
Attendees: IT managers, analysts and designers

NOTE: After preliminary findings have been assembled, there is the potential for a fifth interview workshop to present findings to users for follow-up and clarification. This workshop would be composed of IT executives and managers, bureau chiefs and managers.

Table 1: Workshop Attendee Matrix

ATTENDEES	Strategic & Organizational Level	Operational Level	Info Processes & Methodology Level	Technology & Data Quality Level
Top Executives	X			
Bureau Chiefs		X		
Bureau Managers		X		
IT Executives	X		X	
IT Managers			X	X
IT Analysts			X	X
IT Designers			X	X

Interview/Workshop 1: Strategic Level and Organizational Issues

Discussion Topics:

- Agency's Enterprise modeling experiences
- Agency's incentives/motivations for data sharing
- Strategic role in planning and executing IT systems
- Do executives understand IT opportunities and limitations? Is there a CIO?
- Strategic plan for Intra- Inter-agency data sharing
- Organizational structure e.g. CIO, cross-functional organizational model
- Employee incentives/motivations to promote data sharing
- Accountability
- Who is responsible for strategic planning to build integrated systems?
- What IT functions do executives need? Does IT support those needs? Why or why not?
- What is the role of the IT department?
- Communication gaps between management and IT

Draft Questions for Workshop 1:

1. Modeling Experience:

- What are your needs for (cross-functional) enterprisewide information systems? How important is this need? What do you see as perceived gaps in these needs (i.e., theory vs. reality)?
- What is your experience in enterprisewide modeling? Has enterprise modeling been implemented at the agency? Why was it done? How did it come about? What was your methodology? Is there a formal process? Is spatial data part of the enterprise IT strategic plan?
- Has the perception of IT changed from the modeling exercise? How was the modeling exercise accepted? Did the organizational structure change as a result? Did modeling produce benefits in implementation and/or execution? What *were they*?
- What is the current status of this modeling effort? Is the model maintained and being used? What is the long-term plan?

2. *Organizational Attitude and Role of IT:*

- How would you describe the organizational attitude and culture of the agency?
- What do you believe are the cultural, organizational and political factors that promote or inhibit the execution of integrated systems and data sharing? How do you feel (i.e., positively or negatively) about these factors?
- What are the roles of IT services in the agency? What is the organizational unit structure for IT functions/services?
- Who is responsible for enterprisewide modeling/integration? In other words, who is doing strategic planning to build integrated systems?
- Do you have a CIO, responsible for management of enterprise model implementation, on the top management team? How do you keep top *management updated on IT opportunities and limitations*?
- Was there “buy-in” on your integrated systems exercise? How did you get it? What were some of the obstacles you encountered (e.g., “ownership” mentality, “silo mentality, internal territorialism problems, culture, clash of business practices, conflicting interests, unfunded mandates, etc.)? How did you address these organizational “culture” problems?
- What organizational changes will result/resulted from enterprisewide integrated system deployment? Did you create new job positions (e.g., CIO) or new organizational units?

3. *Agencywide Incentives, Motives and Accountability:*

- What are current incentives/motivations for integrated systems and data sharing at the agency?
- Who is accountable for deployment and execution of integrated systems?
- Is there an “agencywide” group that has formal responsibility for long-term/ongoing evaluation of the integrated system?

4. *Interagency Experiences:*

- Are there major data sharing requirements with other agencies? What are they?
- Is there a formal ongoing process for interagency data requirements?

5. *Recommendations:*

- At the top executive level, what are the factors for success/failure?
- What are recommended best practices?

Interview/Workshop 2: Operational Level

Discussion Topics:

- Unmet functional needs
- Cross functional needs

- What inhibits getting quality data from another functional system?
- Do managers understand IT opportunities and limitations?
- Effectiveness (decision making) vs. efficiency (cost/speed of data processing)
- Is there a communication gap between management and IT?
- Who is responsible for strategic planning to build integrated systems?
- Case studies (as cited in proposal)
- What are the information needs for asset management?
- Are the needs supported? If not, why?
- What inhibits getting quality data?

Draft Questions for Workshop 2:

1. Description:

- Typically, what are the motivation and the objectives of your projects? Please describe a recent project.

2. Strategic planning:

- What process did you use for defining (cross-functional) system requirements? Did you have a formal process with documentation? If yes, briefly describe.
- What were some of your cross-functional requirements for this project?
- Did you work with the IT department on this project? What services did they provide? What were your experiences working with the IT department?
- Was spatial data management included in the project? How was the spatial data managed and what form was it in (i.e., cartographic/location referencing/attribute)? How did you deal with translating between different location referencing methods (LRMs)?

3. Execution:

- Did you work with other bureaus in the same and/or across divisions to obtain required data? What were your experiences?
- How did you resolve conflicting interests, territorial issues, etc., in obtaining data?
- Are there formal agreements with other divisions and bureaus to provide and share data? Please briefly describe these agreements.
- Did any of your projects result in organizational changes?

4. Quality:

- Did you have data quality problems (e.g., location references), with your data and data from other bureaus/divisions on this project?

5. Recommendations:

- Do you consider the project successful?
- What were the critical success factors? Were there gaps in the project's information requirements that affected these success factors?
- What were the high points and low points?
- What are recommended best practices? (i.e., If you had to do this project again, what would you do the same and what would you do differently).

Interview/Workshop 3: Information Processes and Methodology Level

Discussion Topics:

- Agency's Enterprise modeling experiences
- Methodology for system-wide requirements analysis
- Methodology for project-based requirements analysis
- Who is responsible for strategic planning to build integrated systems?
- Location as a data integrator – requirements analysis
- Why do IT shops get a bad rap?
- Organizational culture: providers vs. consumers
- Organizational culture: spatial vs. non-spatial data maintenance
- IT managers incentive/enforcement to use the agency's location referencing method
- Methodology and project lifecycle
- Interaction between functional model and data model; How do cross-functional needs get communicated?
- How does change occur?
- Who is responsible for strategic planning to build integrated systems?

Draft Questions for Workshop 3:

1. Strategic IT Planning / System Experiences:

- What are current incentives/motivations for integrated systems & data sharing at the agency?
- Is there a framework for systemwide planning for IT? Why was it done? Was there a formal process for defining the IT infrastructure plan and is it based on strategic planning? What process was used to develop this framework?
- Who participated in its' development and what particular problems occurred during development? How does it relate to the missions and goals of the transportation agency?
- What were the end results of this framework? What is its' status? Was it created, and if yes has it performed to expectations?
- Did the framework produce benefits in implementation and/or execution? What were they? Did any specific projects result from the IT framework? Please describe them.
- What is the long-term plan of the IT framework and its implementation? How do you ensure that new systems fit into the strategic plan?
- What methodology is used for system development? For process modeling and requirements? For data modeling? Is this methodology adapted from standard system development? Are these methodologies included in the IT framework?
- How is spatial data managed between organizational units (i.e., how is it stored and referenced: cartographic, location measures, attributes)? Is it in different systems? How do you deal with translating between LRM's? What is the role of IT in managing spatial data? Is spatial data part of the enterprise IS strategic plan? Is there a separate spatial data strategic plan and how does it relate to other IT plans?

2. Organizational Attitude and Role of IT:

- How would you describe the organizational attitude and culture of the agency? Do you feel they promote or inhibit the execution of integrated systems and data sharing? Please explain.
- Have you encountered obstacles (e.g., "ownership/silo" mentality, internal territorialism problems, clash of business practices, conflicting interests, unfunded mandates), which impacted delivery of IT services? How did you deal with these organizational "culture" problems?
- Do you feel that executives, chiefs, and managers understand and support the role of IS? Do you feel that these people regard IT as a service or as a critical part of the organizational mission? Do you feel that IT shops get a bad rap? If yes, then why?

- How does the IT department function in the agency (i.e., what services do they provide)? Are these services at the system or project level? What is the organizational unit structure for the IT department?
- What is the role of IT management in strategic planning? What is the role of IT in system procurement? Does it fit within the IT plan? How do you keep top management updated on IT opportunities and limitations?
- Do you have a CIO or someone similar, responsible for strategic planning, implementation, and management of integrated systems identified by the IT infrastructure plan? Is that person on the top management team and what is that person's role? If no, who is responsible?
- Who is responsible for long-term/ongoing evaluation of the IT framework and associated integrated system? Who is responsible for developing system and project priorities?
- With the IT framework, has the perception of IT changed? Were organizational "culture" problems encountered regarding the IT framework? How did you address these problems? How was the framework accepted? Was there "buy-in"? Did organizational changes result from integrated system implementation? What were they?

3. *Project Experiences:*

- What are the motivation and objectives of your projects? Please describe several recent project in terms of:
 - services provided
 - process for defining requirements
 - cross-functional requirements identified
 - inter-departmental interaction experiences
 - spatial data management, format (i.e., cartographic/location referencing/attribute) and translation (between different location referencing methods and coordinate systems) experiences
- For any of your projects, was system development done because of strategic IS planning or changing business needs? Please describe cases where this was true.
- Were there cases when one project evolved, impacted or created another project or system? Please describe these cases.

4. *Recommendations:*

- At the system level, what are the critical success and failure factors? For the project level?
- Describe a recent project. What was it successful? What were the high points and low points?
- What are recommended best practices (i.e., For the projects/systems described in this workshop, if you had to do these projects/systems again, what would you do the same and what would you do differently)?

Interview/Workshop 4: Technology & Data Quality Level

Discussion Topics:

- How do IT shops keep up with sophisticated users?
- Rate of response to technology adoption and systems development
- Process for prioritizing systems development projects
- QA/QC/metadata practices and policies
- Status and strategic plans for:
 - Heterogeneous hardware platforms systems
 - Legacy Databases- migration efforts
 - Inter-agency relationships (e.g., DOA and DOT)

- Technologies for promoting data sharing (e.g., client server, web, data mart, data warehousing)
- Innovative mission technologies using PDA's, remote sensing, etc.

Draft Questions for Workshop 4:

1. Technology Status and Plans:

- Does your agency have an IT framework? Do you have the technological capability to implement this or a future IT framework? How does ISP influence IT decisions?
- What technologies do you currently support for promoting data sharing & system integration? What are your future plans and expectations?
- How do you identify, define, and develop data sharing technologies, such as aggregate databases, data warehouses, datamarts or dedicated databases? Has this changed as a result of your IT framework? What future changes do you expect?
- Is the agency migrating “legacy” (i.e., non-relational/COBOL) type databases? If yes, please describe the process employed? What is the current status?

2. Rate of Response to Technology and Development:

- What is the agency's process for IT adoption? How does the agency identify, evaluate, and make decisions on emerging mission critical IT? On innovative mission technologies? Is the rate of technology adoption and system development acceptable? What would you change?
- How do you prioritize IT projects?

3. Inter- and Intra- agency Data Sharing Experiences:

- Are there major data sharing requirements with other agencies? What are they?
- Is there a formal ongoing process for interagency data requirements?
- Is there a statewide IT architecture, and are you constrained by it? Does it promote data sharing? What are some of the incentives, disincentives, status, problems, and limitations of the statewide IT architecture? Has the statewide IT architecture produced organizational or internal policy changes?
- Is the agency capable of performing inter and intra-agency cross-functional information queries? Please describe your experiences. How do you currently perform these types of queries? Does the statewide IT architecture plan handle these types of queries?
- What are your experiences in working with other bureaus and divisions in obtaining data? How did you resolve conflicting interests, organizational culture, territorial issues, etc?
- Are there formal agreements with other divisions and bureaus to provide and share data? Please briefly describe these agreements.

4. Data Quality:

- What are the agency's QA/QC/metadata practices and policies?
- Have you had data quality problems (e.g., location references) with your data and data from other bureaus/divisions/agencies for projects? Please describe a recent project where data quality was an issue. How did you resolve this problem?

5. Recommendations:

- What are your recommendations & vision to improve data sharing and system integration?
- If you could revise the agencies policy on technology and data sharing/quality (i.e., strategic plans, adoption, development) what would you change and what would you keep?

Appendix E: Summary of Meeting with Wisconsin DOT on Draft Questionnaire

Use of Gartner/GIGA/META

- Comment: "What you are doing is good but you need to know that what you are doing is not new. These best practices are being derived for every state and industry. You are not reinventing or coming up with something new."
- Comment: Using Gartner/GIGA and META you can find out what is going out there. These organizations provide IT consulting to the state as a whole. They have online research notes. A user picks a topic and has different levels of access depending on authority. They also have consultants to talk with, so if you have an issue you want researched you talk to them. Gartner's best practices are not DOT specific but there is a government sector that includes organizational structures. Their comparisons will give examples but not names. A state may be mentioned in discussion but will not be placed on a list.
- Comment: WisDOT has used them for the governance structure, how to manage IT, data management and the importance of data management, content for presentation and training materials, and best practices-what is used in other states and areas and their importance.
- Recommend: Look at the Gartner best practices, through UW's access, with Wisconsin DOT reports and frame the questions around them. Uncover their experiences and successes on enterprise management.
- Comment: On Gartner research used by GIS people, "Geographic data is different and specific from what we are talking about here. People at these conferences (e.g., GIS-T, TRB) are users and business people and not IT people. Data is data is data. I don't use the word GIS anymore."

Project Purpose

- Comment: Your study should be on the educational side of what they don't know. The ultimate goal of this project should focus on making IT more efficient. "We try very hard to educate our users on the importance of data (i.e., why we have data standards and methodology and the importance of following them). We have used data models in setting up our organization and our direction for our data management."
- Comment: "The hardest thing I face is getting agreement on data modeling. No one wants to do it. I hear "My project/data is special, I don't have to do this data modeling". I hear this all the time. Every piece of data is important. Data stays while people may leave or change positions. The managers in these areas aren't IT savvy to understand that modeling this data is critical."
- Recommend: Rather than uncovering best practices, start with a set of best practices that are known (e.g., Gartner), and then measure how they are working in agencies among managers and real people (i.e., uncover best practices on how agencies are adopting Gartner).
- Recommend: Structure questions and organize the data collection/interview phase along best practices. Uncover key success/failure factors and lessons learned from state agencies with regard to these best practices and whether they have helped them achieve their end goals.
- Recommend: The project focus should be key success/failures factors for implementation of existing methodologies. The project team will assume a framework is in place. The problem is how best practices meet reality and how managers actually use these frameworks from textbooks.

Workshop groups: focus and attendees (i.e., strategic, operational, technology, etc.):

- Recommend: Talk with the Technology Management Council. Have a separate discussion with them that is more at the strategic level.

- Recommend: For the strategic level replace “top executives” with Secretary’s office and division directors. The strategic level should include secretaries and administrative levels.
- Comment: Depending on the mix of people there would be tension. People in the divisions want to do their own things and don’t want BAS to manage their data. Separate your discussions. This way you would get a sense of what they think. You don’t want to get BAS and non-BAS people together because you won’t get good answers. You want them to speak honestly and openly on problems and issues.
- Recommend: Replace IT executives with CIO, who is Joyce Gelderman, director of the Bureau of Automation Services. Replace IT managers, analysts and designers with BAS managers, analysts and designers.
- Recommend: Talk with BAS as well as division application people (i.e., non-BAS developers). In the workgroup structure the non-BAS developers should be placed with the bureau managers and division people. I would separate the IT part as non-BAS (i.e., non-BAS developers) and BAS (i.e., BAS CIO, managers, analysts and designers).
- Recommend: Keep bureau managers but replace bureau chiefs with division managers. Applicable division and bureau managers from Wisconsin include Gary Whitehead, Dave Vive, Doug Thompson, Martha Gulch and myself (Jeff Western).
- Comment: The purpose of the operational level is to focus on case studies of actual systems that needed to be developed (i.e., people who are developing a system that responds to a business need) with the result of gauging of how well agencies are actually following these best practices. The people in this group need to be more in tuned with the ins and outs (i.e., people who have experience with the development of particular systems). So we’re uncovering how well the agency is doing in accomplishing the best practices.

Questionnaire:

- Recommend: Questions are very general/abstract and need to be more concrete, so that people can actually use the questions and results when you are done. Understand that best practices are easily available. Write workshop questions in the context of best practices research.
- Recommend: To prevent looking at our work as redundant, results and recommendations should be very specific and tied to best practices from Gartner/GIGA research. The report should allow people to find out if Gartner’s research is working at state DOTs.

Wisconsin DOT as leader in IT infrastructure:

- Comment: “When you look around at other state DOTs, we have the best-managed IT structure. We had a benchmark done where 300 companies were compared; we came out second. When Pennsylvania looked around the country at how state DOTs were managing IT they used Wisconsin as their model.”
- Action: Jeff will provide copies of Wisconsin’s IT structure and how they are doing management. Jeff will also provide a copy of the best practices that they have and the document Pennsylvania used. Jeff will also give the project team a copy of the Gartner benchmark that Wisconsin has for application development.

Wisconsin DOT IT structure:

- Comment: Data structure and infrastructure in WisDOT are centralized under BAS. BAS also programs applications. Some application development occurs outside of BAS (i.e., non-BAS IT developers), but they have to follow the standards and data modeling that we’ve set up. They can’t do their own thing. IT infrastructure (i.e., networks, servers, routers) is managed by BAS. Applications (developed by BAS or divisions) are tied to the infrastructure. BAS applications are typically major and are prioritized as Page 1 projects (infrastructure or application).
- Comment: The Technology Management Council, a steering committee composed of business people, sets the strategy and direction for BAS. They identify what projects BAS should

work on (Page 1 projects). The TMC sifts through and prioritizes these projects that come from the top (i.e., strategic) and some from the bottom (i.e., operational). They are charged with managing the IT plan. The IT plan is linked to the strategic plan and to the division business plans. They also set direction for technology in the department. The TMC defines hardware, software, applications and projects. Joyce, Jeff and division administrators sit on the TMC.

Comment: Critical business areas and gap analysis (i.e., for agency wide information, identify what we have, what we need and the gap) are done at the business unit level. Business units are able to identify these gaps in critical business areas for agency wide application development through IT groups in each division.

Wisconsin DOT Intra-state relationships:

Comment: Wisconsin DOT's IT infrastructure is not dictated by DOA or any other group. However, WisDOT uses DOA's mainframe to share data with other organizations.

Organizational structure:

Recommend: The report should be organized around case studies. With Wisconsin, Michigan and Ohio DOTs, you have three unique case studies Results will be driven by the organizational structure (i.e., what works for Wisconsin will not work for Michigan). Best practices will depend on where you are. Describe the organization and then investigate it.

Comment: The questionnaire has good questions but may not be arranged appropriately for an organization with a different structure.

Recommend: Contact each state using the questionnaire as a starting point to indicate if it is or is not applicable to their organizational structure. It would give you a different perspective

Comment: Wisconsin DOT has an agency centralized IT. Michigan DOTs IT structure is centralized and that makes a big difference. In Michigan, enterprise modeling for transportation is done at the state level only when it comes to IT. This presents a problem in determining strategic applications for transportation. The state wants to determine it but they don't understand that transportation-ware has its own life. Not sure about Ohio DOT. They have not played a role, have not attended or participated in TRB committees/sessions.

Recommend: I think you can use a stable organization like Wisconsin that has the same structure for a long time and compare it with someone like Michigan whose structure has changed drastically (i.e., centralizing IT across the state) over the past 18 months

Appendix F: Summary of Teleconference with Ohio DOT on Draft Questionnaire

Those in attendance: Teresa Adams, UW-Madison, Nicholas Koncz, UW-Madison, Leonard Evans, Ohio DOT, and Shobna Varma, Deputy Director CIO, Ohio DOT.

Use of Gartner/GIGA/Meta:

- Comment: We read it and subscribe to them. There is a big difference between something that is theoretically the best idea and something that is practically the best idea. Gartner/GIGA will give good information on what is theoretically something you want to accomplish. I.e., organizations will look to see what is the recent component I have to put in place in order to make that happen. Then you have to use experience and judgment to figure out what really is an optimal feasible solution in the context of what they are doing.
- Comment: Gartner is not DOT specific. Gartner's research is technology or business oriented (i.e., how do you do data warehousing and what are the best organizations, or best technology in place). You need to look at it and fine-tune it to your specific organization. IT profiles can be obtained through calling each of the state DOTs
- Comment: My general experience is that the organizational line/statement does not represent what is actually happening. Looking at organizational structures won't help. So it is difficult to look at their results realistically. What you are doing now by surveying and getting the state of the practice from the DOTs is more beneficial than trying to pull something out of Gartner. You are better off going to the source than going to Gartner. Had doubts about writing up the report in the context of Gartner stuff.

Project Purpose:

- Comment: The driving force of this project should be the need for integrated information on assets.
- Recommend: Identify: what are the components of asset management, what needs to be in place to make it happen. Think in the context of interfacing versus integrating. Integration is for new systems coming on board and interfacing is for existing systems. Come up with sequential steps saying, these are the 15 things that need to occur in order for asset management to be operational.
- Comment: If I were working on this I would say "a great model to look at would be model X. Based the survey of fifteen states this is what you've found the general pattern to be, that of the 15 states you've looked at, this one is close to being a practically feasible one, all it needs is some amount of fine tuning and here are the things that need to be put in place to get it to be the best model." Or in order to do that "these are the kinds of resources that need to be in place or these are the kinds of technologies that have to be implemented and these are the kinds of maintenance issues associated with that."
- Comment: At the end of this project we are assuming you will be coming up with a list of things that need to be accomplished at the IT end, the executives end, and the operational end. A report valuable to us would say: "this is really where you need to be and where you are, and these are areas of strengths and weaknesses, and if you address these weaknesses you will get to the point that is the goal." This type of report gives a better perspective and then we can look at the points and see if it is worth our while to make it happen.
- Comment: We also would be looking for: "what states have made the efforts on data integration, what have they done, what is the level of effort so far, what kind of utility they are getting out of making that effort, what are some best practices to share about their methodology of achieving that, and how did that work for their organization." As you start to survey the various states you will get an outlook of how the state of art has been progressing at the various state DOTs.

General comments and recommendations:

Recommend: Initially the project was too grand and too much and it's not going to have an outcome that is successful. If you stick to asset management, prune off some of the things discussed and change some of the terminology to make it user friendly, then you have a better chance of success.

Recommend: The context should be clearly identified as asset management.

Recommend: As you start each session you explain your goals. Drive your questions for different aspects of your workshop with the need for integrated information on assets in mind. The audience should know this clearly and at the end each workshop say that: based on this information this is what you understand.

Comment: Ok with questions on trying to uncover organizational attitudes about the role of IT. Ok with second workshop on operational level issues. Ok with attendee matrix.

Workshop 1 comments and recommendations:

Comment: The goal of workshop 1 is to know at the strategic, very high-level administration of the agency their opinions of the information architecture (i.e., do they support it, have they had good experience with it, are they really on board with it). The issue here is how does the high level of the agency perceive information.

Comment: Questions on modeling experience as "“what do you perceive the gaps to be, what is your enterprise information system, what is your experience in enterprise modeling, what is your perception of IT change from the modeling exercise,” assumes that the enterprise modeling process is a new process. Enterprise modeling is an integrative approach, the questions should be more like: “Does modeling exist and how are you integrating your models into your existing systems, etc.

Comment: For the question “what is your experience on enterprise modeling, has it been implemented, why was it done.” There seems to be an expectation that it came about in some process that the user will remember. In the next bullet, “has the perception of IT changed from the modeling exercise?” That seems to indicate that your audience has had this type of experience. It is not an ongoing thing that is new in their minds. So when asking them about your experience with this modeling exercise and has it been accepted, you are injecting a new process into the system and it is not inherently there.

Comment: The questions seem to indicate that either agencies have done modeling or not doing it. In some agencies modeling is a continual and on-going process, i.e., not finished or done.

Recommend: The goal should be identifying what they are doing with integrative asset management. Questions would be “ What are some of the challenges in trying to implement transparent (info is behind but can assess anything from a single point) information, where you are able to deploy it, did you have to bring in new expertise?”

Comment: On the question “What are the current incentives, motivations, for integrative systems,” unless it is a new organization there is not going to be a great deal of integration. There will be more interfacing to make data sharing possible. Integration of systems is not essential, it is interfacing between systems so that data is consistent that is important. Few agencies currently are able to create integrated systems. All new systems are developed with integration in mind. We have many systems that are not integrated but they interface.

Terminology comments and recommendations:

Comment: Enterprise modeling has a totally different connotation associated with it from anyone else outside of IT. Enterprise modeling can be of organizations, processes, programs, and systems. What you are really talking about is data, how it is pulled together, how it's designed. I would re-write your questions to get the same information but with different terminology or define enterprise modeling it right away so that they know exactly what you mean. If you use the term “enterprise modeling” in workshop 1 you would lose your audience. You need to talk about functions and data.

- Comment: When you talk about enterprise modeling, you are talking about integration of data and the inability to do so in asset management systems. You should be asking: “what are the processes you put in place in order to make sure that there is enough technology or structure behind it to bring data together and what are the efforts in that context and is this documented?” and “how do you represent your functions using modeling, how do you work with your data using modeling, how do you capture that”.
- Recommend: The goal is to get to the root of how they are dealing with data, how are they dealing with their functional organizations and how they are putting them together. Work in the user’s terminology.
- Recommend: Either scratch the modeling questions all together, re-word them or put them in later after you get going. Somewhere up front you must talk about asset management. Provide clarity up front when talking about modeling and integration.
- Recommend: Instead of using the question “who is responsible for enterprise modeling and integration” use “who is doing strategic planning to build integrated systems and what is the process being used.” Strategic planning for integrating information is something they will relate to
- Recommend: Executive management will not have an understanding of the question “what documents resulted from this process?” Instead use “what is/was the outcome”. You are looking for “what utility you got from doing that integration?”
- Comment: Remember when you are bringing this audience together that they have very high hourly rates so they will try to give you information as quick as possible.
- Recommend: Fine tune the document. Your question on “what organizational changes have resulted from enterprise wide integrated system deployment” should be rephrased as “In trying to get asset management information integrated, what were some of your challenges, did you have to create new jobs, etc.”

Workshop 3 comments and recommendations:

- Comment: The data quality component is very, very important. It doesn’t matter what IT framework you are using; the data framework and having a process in place where data is integrated, whether it is system integrated or interfaced (i.e., you can get similar data across the board) is important.
- Comment: New systems come on board that work well with existing data and old data is stored in a single repository where it can be accessed across the board, with the same meaning and can communicate with each other. Everything we are doing is to get to that point (i.e., what infrastructure do you need to put in place, what is the operational stuff you need to put in place, how you do your planning, how you ensure integrity, and what type of business processes are in place to maintain the system).
- Recommend: For workshop three talk about data quality, cross-functional stuff as functional models and data model stuff and how does change occur. Merge interaction between functional models and data models (i.e., how do functional units operate with their data in the context of other functional units and who has ownership) into data management and data quality discussions from workshop four.
- Recommend: (Shobna) Include business people in this workshop: “Though IT people are the keepers of the data, the ones who use the data and have ownership are the business units. I think you need to have business units there. Final data quality is a result of business operations. There is only so much that technology can do to make sure the data good, so the responsibility at least here in Ohio DOT is with the business unit, to make sure the data is correct. There are only certain checks and balances you can put in place, but beyond that its’ a business operation. We have business processes that enforce it but not all of it has technology on top of it.”
- Response: Data quality for business units is part of workshop two, where we were trying to uncover whether business people even understood that there is a need across functions to share

data and whether they buy into that. Having IT people in workshop 3 allows us to understand what IT is doing to help business people manage data.

Recommend: Take off questions on the IT framework.

Workshop preparation comments and recommendations:

Action: Leonard will help get the right people to pull together to provide Ohio's perspective. Teleconferencing is provided as an alternative to in-person visits.

Action: Shobna will help identify if there are any documents or information at Ohio DOT that can provide a better understanding of the agency (i.e., if you've done any of this enterprise stuff or these types of modeling, how you have your IT set up, how you make your IT decisions, and if you have committees that help make some of these decisions). So that when we go in, we have some background and can build upon what is already known. Her phone number is 614-466-3553, svarma@dot.state.in.us

Recommend: Come up with another set of basic background questions, such as "Do you have a centralized data or decentralized data approach" to understand how Ohio DOT goes about doing things in the context of IT asset management. One month prior to coming over, have a telephone conference with Shobna and go over these questions. Some documents will contradict other documents. You will be spinning your wheels reading. This way you have the opportunity to follow-up right away.

Recommend: Send a list of questions before the workshops. The workshops should be done after March and be no more than 90 minutes each. If it is much longer you will lose your audience. Structure workshops correctly to drive out the right information.

Appendix G: Summary of Teleconference with Michigan DOT on Draft Questionnaire

Those in attendance: Teresa Adams, UW-Madison, Rafael Lazimy, UW-Madison, Nicholas Koncz, UW-Madison, and Ron Vibbert, Michigan DOT.

Use of Gartner/GIGA/META

Comment: Gartner will come up with best practices but those are typically at a high level saying you ought to do this and that, or they are at a very low level saying this tool is better than that tool. Their research is more on the technology side. This project is very situational, your questions should be “what are you guys actually doing and how do you address these issues using Gartner’s best practices and did you know about the best practices?” From the business standpoint Gartner provides no knowledge.

Michigan DOT IT Structure:

Comment: The asset management section at Michigan DOT manages five management systems as one large application using one large database. Only one or two systems out of the five are planning-oriented (i.e., intermodal management system and congestion management system). The management systems themselves are the owners of systems (i.e., pavement, safety and bridge groups). This section maintains their databases and provides applications to them. It has been more of a business concern that MDOT keeps this stuff together than a technical concern.

Comment: Asset management section functions include: data integration, HPMS reporting, condition monitoring, maintenance of bridge and crash data, and accounting for all the roads in the state. The section includes a GIS team and a GIS/data management group. The section is the primary contact between Michigan DOT and the Michigan Department of Information Technology, which maintains our statewide GIS base map.

Comment: Bureaus are in planning, delivery (i.e., construction), development (i.e., design and preparation of plans), and finance. MDOT used to be a very centralized organization. MDOT has moved to a decentralized operation where many decisions are made in decentralized locations. The trick with that is to maintain a central focus instead of managing fiefdoms.

Comment: MDOTs business model puts information technology resources in the business area; at least to maintain applications. Folks from IT report to Ron on a day-to-day basis, but do not sign their timesheets.

Comment: MDOT does not need to go to the state level for project prioritization, unless the platform that they start to propose things conflicts or will involve the state web portal. The central department of information technology has not been in existence to go through MDOT’s project identification cycle. Historically, bidding, not obtaining permission, requires going to a central agency. Projects are approved at the executive level in the department. The IT department doesn’t have to approve those things at that point. Michigan does not have a statewide IT plan and is thereby not constrained by the statewide IT architecture plan when developing projects.

Comment: ERP status in the state includes implementation of some common cross-department stuff like HR and finance systems, and the statewide GIS base map. There is nothing in the mix to expand these systems. Ron commented that he never got a good understanding of what folks mean when they talk about ERP.

Comment: MDOT started looking at data integration when executives realized that they got four or five answers to a problem. Each of them might be right depending on whom you asked for the information. That told MDOT executives that they didn’t know what they had (in terms of data quality). They couldn’t deal with the legislature or had a hard time dealing

with the newspaper because the newspaper could always quote somebody in the department that had a different answer than what the director had from his own sources.

General comments and recommendations:

- Recommend: Add questions on the organization being able to identify opportunities for data sharing: e.g., “is the process/environment wired so that people know enough to take advantage of someone else?”, “are there opportunities an organization can take to override the individual project manager’s interest and do something for the greater good?” Do we present that decision-making, those integrative kinds of activities and opportunities to someone who has the authority to make it happen? Are people looking for data sharing opportunities and even if there are opportunities, is there a way of promoting that?
- Comment: Assume that every DOT has an ISP and has adopted an enterprise-wide approach to information systems and information technology infrastructure. ISP completion status may vary from state to state. MDOT had an ISP and executed it. Now need to know what to do next because their whole world has changed in the last two years. MDOT currently does not have an ISP, but has a common cultural understanding on the business side of how they want their IT to look. They just have to codify it
- Comment: Folks may or may not have an idea of what best practices are with respect to data integration. It is hard to come up with a way of implementing best practices unless you have a high level view of what the organization is supposed to be when you are only given technical systems to work with. A question should be: “Do you have an overall strategy for what you need to implement, and do you have the mechanisms in place to do it (i.e., from the questionnaire: “Do you have an ISP?”)?” If an ISP is not present, then it’s hard for an executive, if their tenure is short to take a longer view and make this strategy. It takes an executive view to encourage people to implement strategies that are broader than an individual scope. This executive view may not exist or executives don’t know they can do that. An ISP or a broader plan helps here. So there are two issues: not having an idea of what you even have and not recognizing from an upper level that you have opportunities to change things
- Comment: Many people ask for a system because they have a very particular need or time constraints. Making a project as narrow as possible increases the individual’s chance of success and using data integration elements increases the risk of their project being rejected.

Workshop 1 comments and recommendations:

- Comment: Asking MDOT executives if they had a cross-functional enterprise model or talk about data models, would produce blank stares. If you ask that question of IT executives you should get a reasonable answer but if you asked the chairman of our department, they wouldn’t have a clue. Questions like: “Do you have a plan for integrating data or interfacing systems?” would not be understood at the executive level. This question is far removed from what executives do in the agency. On the IT side I would expect really good answers if they were next to their department chief. More relevant questions are “what are the benefits of data sharing or data integration to a high level executive” or “how would a high level executive know that things are not right?”
- Recommend: Instead of using “enterprise modeling” use: “do you have a map of how your operation works?” That would communicate better than “enterprise model.” Executives may or may not know what “modeling” means.
- Recommend: Ask questions centered on executives perspective with regard to communicating to the legislature or to the newspaper. It’s not my sense that you would have too many executives who would be able to analyze and say “I’m getting this because I have poor data quality or our enterprisewide IT model is bad or because our ISP is bad.” I can’t imagine that would be a first response from their department director.
- Recommend: Probe executives on how they have made changes in the information system. Pick business scenarios relating to asset management and ask specific questions like: “where

do you experience pain?” and what kind of changes they made in their organization or their information organization so that they could produce the information they need and respond to budget justification or funding requests, etc. The follow-up question is then: “What barriers do you see in your organization to changing the way information technology serves you?” Other questions include “how do you use IT to help support your decision-making?”

Workshop 1 Reliability/Predictability Topic:

- Comment: Your chief executive may have trouble dealing with the legislature or newspapers or local politicians and they are having a hard time getting their answers to their questions or worse they get more than one. They might have promised their legislature some results and they’re having a hard time achieving it. It maybe because they based their promises on bad data or they cannot produce any proof that something has occurred, i.e., it may be a data issue but they did not understand what their technical people are telling them. An executive would hand it off to a bureau chief and say, fix this and ask “which one should we use, how come you guys can’t agree and don’t you guys know what you are doing, etc?” For MDOT, pain was exerted from the top. So either your data is out of line and you need to fix it or your systems are in deep trouble.
- Comment: For top executives, i.e., secretary level, information needs that necessitate system integration and data sharing include predictability. The certainty of the information provided by their staffs as they go forward to present themselves to their colleagues, legislatures, governor, their boss is important. Predictability is really a good thing and when they can’t rely on what their people are telling them, they are in trouble.
- Comment: Predictability of results type questions include: are the databases stable, would you get the same answer if you asked three people and are the systems stable enough, from a day-to-day basis, that you get the same answer? The organization should know it can produce the answer and the organization should know that you get the same answer no matter whom you ask.

Workshop 1 Funding Topic:

- Comment: A relevant business scenario for top executives and upper management is using asset management reporting for funding requests at state and federal levels. The executive level makes decisions, through directing funds and resources to achieve goals.
- Comment: If you are going for a tax increase, you could show that you have been monitoring your pavement condition over time, that you are wisely expending your money and that the increase in funding will be used to achieve certain goals. To do this you need to have a good data history, know what your data means, know the numbers are reliable, the data can stand up to an audit, and be able to defend the data. Audits find more than one source for a piece of information to justify numbers.
- Comment: Ron could not answer questions on state allocations based on performance and distributions (i.e., how they divide monies up). MDOT tries to make everything performance based and allocates money to regions so that the statewide goals are met. Everyone doesn’t get the same goals and everyone doesn’t get the same per mile set of funds.
- Comment: Currently management systems do not feed into the decision process on fund allocation. The programming guys and the management system guys are aware of this gap. The plan for strategic systems is there and the mindset is there, but execution is light and requires time.
- Comment: Would like MDOT to see what finance systems support engineering functions and tack on a couple of attributes we need to do to get the complete picture (i.e., link finance systems with our engineering systems for programming and planning decisions).
- Comment: If you are doing GASB and the modified approach you should be using your management systems. And if you can withstand an audit with this approach, chances are that you are

not doing badly. You are basically getting your asset management process audited. MDOT has withstood two audits; it's been in our financial report.

Recommend: Given enough time you can ask how they are using their information systems to justify the GASB modified approach.

Workshop 2 comments and recommendations:

Recommend: Focus on asset management systems for performance measurements, bridges, pavements, and recent work on data integration to do performance measurement stuff (e.g., newer ones rather than PONTIS). Look at inventory management, i.e., how you control the inventory, how do you know what is in your inventory and data quality at that level (i.e., do you really have 2000 bridges or 2500 bridges and how do you know).

Recommend: Look at what systems they are doing, how does that translate into projects, and how do you know your asset management routines. This allows answers to questions as "how do you monitor your bridge condition so that you are picking the right projects." We've got it monitored; now how do we roll it into our day-to-day stuff. Ask open questions such as "how are you relating inventory information to measure performance" to find out what systems they are doing.

Recommend: Ask bureau chiefs operational questions like: "Do your business systems meet your needs?" and from there ask, "Why do you say that?" You could get answers like: "they are too expensive, they aren't very friendly, I have to consolidate the output from too many things, they require re-keying of data." This leads to data integration issues of handling multiple systems, multiple databases, and re-entry of data, which leads to questions as can you translate the data; are the referencing systems compatible? These issues lead to data not being defined in the same way, which leads to data modeling. All these issues are valid for people actually doing work.

Comment: One issue important on the operational level at MDOT is HPMS reporting. MDOT gets hammered on their numbers because people are misusing the data. Of particular interest is reconciling air quality stuff with HPMS data that underlies federal submittals. It makes data quality important real quick, if your underlying HPMS data is wrong.

Workshop 3 comments and recommendations:

Comment: On the questionnaire data quality is classified an IT function, but believe it is primarily a business function. You need to know the quality level of your data to decisions on it. Data quality has to be on some level a business function even though they may not understand the technical aspects.

Comment: Data quality is applicable for IT and business units. A question such as "What quality level do you need to have to make decisions" leads to the issue of having data accurate to the nearest centimeter, or to the nearest 50 feet. Depending on the decision you make, one is overkill and the other is not. You wouldn't design a road to the nearest 50 feet and conversely you don't need centimeter accuracy for policy decisions.

Comment: Data quality, data sharing, cross-functional systems, etc. can influence meaningful cuts or pain minimization. Asking if data quality is important is like asking about "mom and apple pie."

Comment: Data quality stuff can be from two sides. One side can look at data standards and metadata documentation and if they have the technical systems in place to enforce these documents. The other side can look at the ability to aggregate data from various applications.

Linear Referencing Issues:

Comment: Regarding (linear) referencing issues, at MDOT it was a decision an executive had to make. Someone had to say that these are the primary/fundamental referencing methods we are going to use and we couldn't tolerate having 5, 6, or 10 ways of referencing the

same thing. There had to be a standard somewhere with the decision made at the executive level. Our chief deputy director made the decision on this. Everyone experiencing so much pain and no one could resolve it.

Comment: Executives need a good analysis of what the problems are to decide, but most stuff, unless told, are way out of their depth. They don't have time to deal with referencing systems and related things. They need someone to identify and explain the importance of making a certain decision and why it's not made at a lower level. Some of fundamental decisions surrounding data/systems integration have to be made at that level because it will require overriding everyone's short-term interests to achieve the longer-term interests.

Workshop preparation comments and recommendations:

Recommend: Plan ahead to get an audience with executives at MDOT. The department is bifurcated. There is an administrative side and a highway operations side. Ron is more on the administrative side. The head of the administration side is an IT guy. If you got him and the guy who used to be our CIO in the room, it would be really productive for workshops one or two.

Recommend: For workshop 2, have the highway operations guy and Ron in a room to talk about how MDOT is taking their inventory systems and pulling them together to manage performance.

Comment: Ok with attendee matrix and using CIO to represent IT executives. Often there is one IT executive in an organization and that is the CIO. The top executive is the department chair.

Comment: Ok with starting with the lower level and work up in the order of workshops to understand more about these systems and ask reasonable questions at the top level. Correlate the discussion in the lower level with the higher level. Another option is to start in the middle and see what answers you get and do some reality checking as you go down.

Comment: Ron Vibbert is the contact person to provide information how MDOT goes about planning its' IT (i.e., org chart, procedure for project prioritization). He is the chair of the unofficial internal MDOT IT governance committee.

Action: Send Ron an email with a list of things to pull together, such as business plans and visions statements. Also send Ron and the research team a copy of questions and answers developed for the new Secretary of Wisconsin DOT about the agency (e.g., mission, systems, etc.).

Appendix H: Background Information Request

To: Leonard Evans and Shobna Varma, Ohio Department of Transportation
Ron Vibbert, Michigan Department of Transportation
Jeff Western, Wisconsin Department of Transportation

From: Teresa Adams
teresa.adams@dot.state.wi.us
608/266-1380

Date: 4/24/2003

Re: Request for Information for MRUTC Research Project
"Synthesis of Best Practices for the Development of and Integrated Data and Information Management Approach (to support Asset Management)"

The Research Team will use the requested information as background to prepare for formal interviews with participants at your DOT and to customize the interview questions for your DOT. In preparation for the interviews, the Research Team needs to become familiar with plans and activities at your DOT regarding asset management and information systems development.

Please use the following list as a guide for identifying relevant documents or other references that already exist at your DOT. We are not requesting extra work on your part aside from identifying, gathering, and providing to me any existing material that describe your DOT structure and business plan, asset management at your DOT, and information systems development process at your DOT.

We need this information by April 4 to stay on schedule for project completion. Please contact me if you have questions or need more time.

1. High-level information about the DOT

- a. Organizational Chart (including descriptions)
 - i. What parts of the organization are responsible for asset management activities?
 - ii. What parts of the organization are responsible for information systems activities?
- b. DOT Annual report and biennial business plan

2. DOT's Asset Management Systems Activities and Plans

- a. Agency's business plan for asset management
- b. Information about the DOT's asset management systems (current and emerging), including individual contacts and development processes (e.g. Ellis system at ODOT, Metamanager at WisDOT, Compass at WisDOT).

3. DOT's Information Systems Management and Development

- a. Role of IT/IS departments in strategic information systems planning (in general) and in asset management systems planning and development (in particular)
- b. Descriptions of the agency's formal or informal processes for strategic planning of information systems with particular focus on achieving data and system integration
- c. Formal guidelines/procedures for managing data model evolution and metadata
- d. Descriptions of data repositories, architectures and data models employed by the agency for asset management

Appendix I: Updated Interview Questionnaire

Synthesis of Best Practices for the Development of an Integrated Data and Information Management Approach

Teresa M. Adams, Rafael Lazimy, Nicholas Koncz
University of Wisconsin-Madison
April 4, 2003

Strategy:

The Research Team will study background information provided by each state (Michigan, Ohio, Wisconsin).

The Research Team will visit each state to conduct three separate interviews. The following interview questions will be customized for each state DOT according to the background information. If possible, the interview questions will probe unique strengths/strategies of each DOT. Each interview is 1.5 hrs long. If a face-to-face interview is not possible, then a teleconference will be scheduled.

Interview 1: Management Perspective and Organizational Strategies

Abstract: The purpose of this workshop is to identify lessons learned and best practices for the role of DOT top management in developing integrated data and information systems to support Highway Program planning and evaluation. The scope of the workshop is the State Highway Program (major highways, state highway rehabilitation, and state highway maintenance) and experiences using the state's bridge and highway inventories, condition and inspection records, deterioration models, GIS database, maintenance records, project records, etc. to optimize and evaluate highway programming decisions.

The interview questions focus on the top managements perspective of the benefits, challenges and experiences with data integration projects and on the role of the IT/IS unit in the agency

Attendees: Secretary's office, Division Administrators, and CIO.

Strategy: The interview questions will be customized for each state DOT. If possible, the interview questions will probe unique strengths/strategies of each DOT.

1. How have recent concepts of asset management influenced planning and evaluation of the highway program at your agency? Please consider the following definitions of asset management:

(FHWA) Asset management is the systematic process of maintaining, upgrading and operating physical assets cost effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized logical approach to decision making. Thus, asset management provides a framework for handling both short and long-range planning.

(TRB) Asset management is a systematic process for maintaining, upgrading and operating the physical assets of a transportation system. Asset management employs engineering principles, economic theory, sound business practices, and information systems to determine short and long-term resource allocations.

(APWA) Assets management is a methodology to efficiently and equitably allocate resources amongst valid and competing goals and objectives.

2. Business cases (reasons) for integrating data/systems to support highway programming.

*a) What are the **motivations/incentives** for integrating data/systems?*

- b) *What are the benefits of data sharing or data integration to a high level executive?*
- c) *What are the **goals** for integrating data/systems? Does the DOT have formal **performance measures** for integrating data/systems?*
- d) *Do **federal and state mandates** impact the business case for integrating data/systems?*
- e) *What are the **long-term challenges** (i.e., getting system payoffs, patience to see a product/outcome) that impact the decision for integrating data/systems?*

3. *DOT's past/current experiences in integrating data/systems to support highway programming.*

- a) *What are the DOT's experiences in data integration and interfacing projects?*
- b) *What do you believe are the cultural, organizational and political factors that promote or inhibit the execution of integrated systems and data sharing? How do you feel (i.e., positively or negatively) about these factors?*
- c) *What **barriers** have you encountered?*
- d) *Are the new systems working? How do you know?*
- e) *Who was involved in the strategic planning for the integrated systems and what was the process used?*
- f) *How were **DOT organizational/managerial strategies changed** in response to data/system integration efforts?*

4. *Role of the CIO and IT services/department.*

- a) *What is the role of IT department in data/system integration efforts?*
- b) *What was the perception of the modeling exercises? Did modeling produce benefits in implementation and/or execution?*
- c) *How do top management stay updated on IT opportunities and limitations?*
- d) *What if any are the organizational changes resulting from enterprise-wide integrated system planning/deployment?*

5. *What do you need to know? What best practices, lessons learned, guidelines could you share with other states? What has worked well and what were disappointments?*

Interview 2: Integration Case Studies

Abstract: The purpose of this workshop is to gather lessons learned and best practices from the business manager's perspective. This workshop focuses on the DOT's experiences in working across organizational boundaries, data sharing, and integrating or interfacing systems. Case studies focus on recent or current efforts to integrate/interface systems for highway budget allocation with systems that manage the state's bridge and highway inventories, condition and inspection records, deterioration models, GIS database, maintenance records, project records, etc.

Attendees: Division and Bureau managers who are/have overseen the development of integrated data/systems to support some aspect of highway program planning or evaluation. Division and Bureau managers involved with planning and evaluating the state's highway program.

Strategy: The interview questions will be customized for each state DOT. If possible, the interview questions will probe unique strengths/strategies of each DOT.

1. *Describe the DOT's systems for planning and evaluating the state's highway program?*

- a) *What does each specific system do?*
- b) *What is the DOT's business case (reason) for each specific system? In other words, why is this system important?*
- c) *Do your business systems meet your needs? Why do you say that?*
- d) *Can you translate data; are the referencing systems compatible?*

2. *Case study questions that focus on planning a project that integrates data from multiple data systems:*

- a) *What were the motivation, objectives, and expected outcomes of the project? Were outcome measures developed to justify the system? What were they?*
- b) *What specific systems were integrated?*
- c) *Did you work with the IT department on this project? What services did they provide? What were your experiences working with the IT department?*
- d) *What were the perceptions and experiences in strategic level planning for this system?*
- e) *What process did you use for defining (cross-functional) system requirements? What were some of your cross-functional requirements?*
- f) *Was spatial data management included in the project? How did you deal with translating between different location referencing methods (LRMs)?*
- g) *What quality level do you need to have to make decisions?*
- h) *Did you have a formal process for documentation? If yes, briefly describe.*

3. *Case study questions that focus on working across organizational boundaries:*

- a) *Did you work with other bureaus in the same and/or across divisions to obtain required data? What were your experiences?*
- b) *Did you have data quality problems (e.g., location references), with your data and data from other bureaus/divisions on this project?*
- c) *How did you resolve conflicting interests, territorial issues, etc., in obtaining data?*
- d) *Did the projects result in organizational changes?*
- e) *Where there formal agreements with other divisions and bureaus to provide and share data?*

4. *Case study questions that focus on system deployment, evolution, and maintenance:*

- a) *What are the **performance measures** for this system? Is the system working? How do you know?*
- b) *Were there any unforeseen problems with sharing data?*
- c) *What are/were the DOT's experiences in system evolution? How is/has the system evolved? Did the system impact the existing data model repository?*
- d) *What are/were the DOT's experiences in data quality of this system?*

5. *What do you need to know? What best practices, lessons learned, guidelines could you share with other states? What has worked well and what were disappointments?*

- a) *What were the critical success factors? Were there gaps in the system's information requirements that affected these success factors?*
- b) *What were the high points and low points?*
- c) *What are recommended best practices? (i.e., If you had to do this system again, what would you do the same and what would you do differently).*

Interview 3: Information Processes, Methodology and Data Quality

Abstract: The purpose of this workshop is to gather lessons learned and best practices from the perspective of the DOT's information systems experts about integrating/interfacing existing information systems to support asset management decision-making. The scope of the workshop includes prioritization and development processes; technological strategies for data sharing, system integration and interfacing, managing data quality, integrating location-based data; and the role of DOT's IT/IS unit in the agency's strategic planning process.

Attendees: CIO, IT managers, analysts and designers.

Strategy: The interview questions will be customized for each state DOT. If possible, the interview questions will probe unique strengths/strategies of each DOT.

1. Role of IT/IS unit to support inter-departmental information systems initiatives:

- a) *What services do you provided?*
- b) *What is the process for identifying and prioritizing system development projects? Who is involved?*
- c) *How do you manage the impacts of a new initiative on other projects or systems?*
- d) *What is the process for defining system requirements?*
- f) *For (b), (c) and (d), do you have performance measures for these processes? What are they?*
- e) *How do you currently perform inter and intra-agency cross-functional information queries?*
- g) *What are your experiences with facilitating data sharing across bureaus and divisions? How did you resolve conflicting interests, organizational culture, territorial issues, etc?*
- h) *What are the incentives/motivations for organizational units to share data?*
- i) *How would you describe the organizational attitude and culture of the agency? Do you feel they promote or inhibit the execution of integrated systems and data sharing? Please explain.*
- j) *Are there formal agreements with between bureaus, divisions, and agencies to provide and share data?*

2. Technological strategies for these cross-functional systems:

- a) *What are the DOT's technological strategies (e.g. metadata and data warehousing) for **data sharing, integrating and interfacing**?*
- b) *How do you identify and develop data sharing technologies, such as aggregate databases, data warehouses, datamarts or dedicated databases? Has this changed as a result of your IT framework?*
- c) *What is the agency's process for IT adoption? How does the agency identify, evaluate, and make decisions on emerging innovative technologies or mission critical IT?*

- d) *What are your future plans and expectations for technologies that promote data sharing & system integration?*

3. Managing data quality:

- a) *What are the agency's QA/QC/metadata practices and policies?*
- f) *What is the process for identifying data quality requirements?*
- g) *What is the process for evaluating data quality?*
- h) *Please describe a recent project where data quality was an issue. How did you resolve this problem?*

4. Strategies for integrating location-based data:

- a) *What is the role of the IT/IS unit in managing spatial data?*
- b) *Is spatial data owned and managed by different organizational units? If so, how is it stored and referenced: cartographic, location measures, attributes?*
- c) *How is spatial data shared across different organizational units? How do you deal with translating between LRM's?*
- d) *Is spatial data part of the enterprise IS strategic plan? Is there a separate spatial data strategic plan and how does it relate to other IT plans?*

5. Experience with ISP/Information framework development:

- a) *Is there a framework for system-wide planning for IT? Why was it done? Was there a formal process for defining the IT infrastructure plan and is it based on strategic planning?*
- b) *What were the end results of the ISP/framework? What is its' status? Was it accepted? Has it performed to expectations or produced benefits?*
- c) *How does ISP influence IT decisions? What is the role of IT in system procurement?*
- d) *What process was used to develop this framework? How do you ensure that new systems fit into the strategic plan?*

6. Role of IT/IS unit in the DOT's strategic planning process:

- a) *What is the role of IT management in strategic planning for the agency?*
- b) *Is IT/IS unit regarded as a service or part of the organizational mission?*
- c) *How is top management kept updated on IT opportunities and limitations?*
- d) *Is there a CIO or someone similar, responsible for strategic planning, implementation, and management of integrated systems identified by the IT infrastructure plan? Is that person on the top management team and what is that person's role?*
- e) *Do executives, and business managers understand and support the role of IT/IS?*

7. What best practices, lessons learned, guidelines could you share with other states? What has worked well and what were disappointments?

- a) *What are recommended best practices?*
- b) *What are critical success and failure factors?*
- c) *What are your recommendations & vision to improve data sharing and system integration?*
- d) *If you could revise the agencies policy on technology and data sharing/quality (i.e., strategic plans, adoption, development) what would you change and what would you keep?*