KANSAS
DEPARTMENT OF
TRANSPORTATION

Final Report

Geographic Information System Strategic Plan

Prepared by

Geo Decisions
A Division of Gannett Fleming, Inc.

in Association with
Tripe I Corporation

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Introduction

This report is produced under contract between the Kansas Department of Transportation and Geo Decisions, a Division of Gannett Fleming, Inc., in association with the Tripe I Corporation with the goal of producing a Geographic Information System (GIS) Strategy Plan. The report was prepared to present the strategies and action plans needed to advance the development of a Department-wide GIS. The Strategic Plan Report will serve as a "road map" for the future development of GIS within the Kansas Department of Transportation.

Kansas Department of Transportation
GIS Strategic Plan
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Executive Overview

The Kansas Department of Transportation (KDOT) developed its Geographic Information System (GIS) capabilities in the 1980s to support important regular Agency business processes. While the value of GIS has been proven and become evident to many in KDOT, GIS implementation has proceeded slowly and incrementally. Staffing and organizational limitations have contributed to this situation.

There are new opportunities for GIS based upon the Comprehensive Transportation Program (CTP) initiative currently being implemented at KDOT. GIS can offer new capabilities, introduce efficiencies to existing processes, and provide cost and time benefits throughout the Agency. Use of GIS to assist in identification and prioritization of projects for the CTP should be a primary goal for KDOT over the next few years.

As the last strategic plan for GIS at KDOT was prepared in 1995, the timing is appropriate to update and augment a coordinated plan for GIS for the next several years. This document contains a Management Plan for GIS that includes a GIS mission, vision, and goals; identification of critical issues and success factors; strategic objectives, action plans, and performance measures; and specific project application recommendations and schedules for the period 2001-2003. In addition, complementary material from KDOT's Information Technology Architecture Plan is incorporated. Finally, supplemental material such as a situation analysis document, interviews summaries, and project application templates are provided as appendices.

As the 21st Century begins, GIS is poised to fulfill an increasingly beneficial role at KDOT. This GIS Strategic Plan will function as the blueprint to guide successful GIS efforts for many years to come.

The following Executive Summary presents in brief form the major conclusions and key points of the GIS Strategic Plan.

Executive Summary

Plan Process

- The purpose of the GIS Plan is to define and document the KDOT planned GIS direction for the next several years.
- This GIS Strategic Plan updates the "GIS Directions Report" that was developed in 1995, taking into consideration emerging technologies and new Agency needs, particularly those of the new CTP.
- The following project goals guided the development of the GIS Plan during this update.
  - Support the mission and objectives of the Agency.
  - Seek input and consensus on the plan.
  - Prioritize GIS efforts and projects in an effective manner.
  - Recommend a GIS funding level sufficient to support proposed efforts.
  - Prepare for future GIS needs.
- Project milestones:

June 1998	Began researching other strategic plans
September 1998	Selected consultants for GIS strategic planning
October 1998	Project kick-off meeting and initial interviews
November 1998	Began Analysis Phase
January 2000	Issued GIS Plan (DRAFT) for committee review
March 2000	Issued final GIS Plan report.

GIS Direction

The development of this GIS Strategic Plan required information from all of the cooperating organizations and stakeholders who may be involved with GIS. The process consisted of three primary means of information collection. The first method was the KDOT GIS Subcommittee kick-off meeting and Visionary Workshop©, which together provided a two-way flow of information. The second method was a series of direct interviews of KDOT staff by Geo Decisions personnel. The third method was the completion of proposed application templates for priority GIS applications throughout the Department.

The Visionary Workshop© produced the following Mission Statement, Vision Statement and Strategic Goals:

GIS Mission

To develop and distribute a user-friendly Geographic Information System (GIS) environment that can advance data sharing and decision-making throughout the

Department to improve quality and timeliness of services. To accomplish this mission we place high importance on:

- Access to Data
- Data Quality and Accuracy
- Customer Service
- Partnering/Teamwork
- Continual Improvement.

GIS Vision

The Kansas Department of Transportation has a GIS that provides easy access, integration and distribution of transportation information.

GIS Strategic Goals

- Support the Comprehensive Transportation Program Initiative.
- Integrate GIS with other emerging technologies (GPS, Videologging, ITS, etc.) in the Department.
- Standard LRS should support other Location Referencing Methods (GPS/xy coordinates, addresses, other linear measures).
- Utilize GIS for the integration of the Department's transportation data.
- Develop user-friendly GIS solutions which staff can use to easily obtain information.
- Provide GIS backing through information, education, training, and support structure throughout the Department.

GIS Management Strategic Goals

- Create a management structure capable of providing the planning, budget and implementation for an expanded GIS environment.
- Blend GIS into the day-to-day business functions of the Department.
- Promote and distribute GIS technology throughout the Department.

Critical Issues

Critical issues can be defined as those major, broadly-defined areas or elements that must be addressed by specific actions to achieve GIS success. The three main Critical Issues were determined to be:

- Organizational
  - Staffing Support
  - GIS Distribution
  - Training and Education
  - Data Access and Sharing Improvements
  - GIS Management Structure
  - Development of Realistic, Measurable Goals

- Basemap
    - Basemap Resolution
    - Data/LRS/Route System Translators
    - GPS Accommodation
    - Historical and Temporal Data Management
- Technological
    - Software Choice
    - Data Migration to Relational Database Management Systems (RDBMS)
    - Development of GIS Pilot Projects
    - Internet Access to GIS Data
    - Intranet Access to GIS Data.

Strategic Objectives, Strategies and Action Plans, and Performance Measures

To be successful in meeting concerns associated with the above issues, several ***Critical Success Factors*** were identified for each, then strategies were proposed, enhancements for GIS were documented, and specific performance measures for monitoring GIS success were collected.

Priority GIS Projects

Geo Decisions distributed a GIS application template to be completed for potential application throughout the Agency. Twenty-nine (29) proposed GIS application templates were completed and submitted by KDOT staff.

- A Time and Cost Estimate Table was prepared. Each proposed application was evaluated for the following factors:
    - Costs for data development
    - Costs for application development
    - Cost of hardware and software purchases
    - Consultant time for implementation
    - Consultant time for data development
    - Consultant time for system documentation
    - Consultant time for user guide preparation.
- A Feasibility Measure Scoring Table was prepared. Each proposed application was rated for the following factors, then scores were totaled and ranked:
    - Data availability
    - Level of development effort
    - Degree of clearly defined end product
    - Maintenance
    - Complexity of use
    - Frequency of use

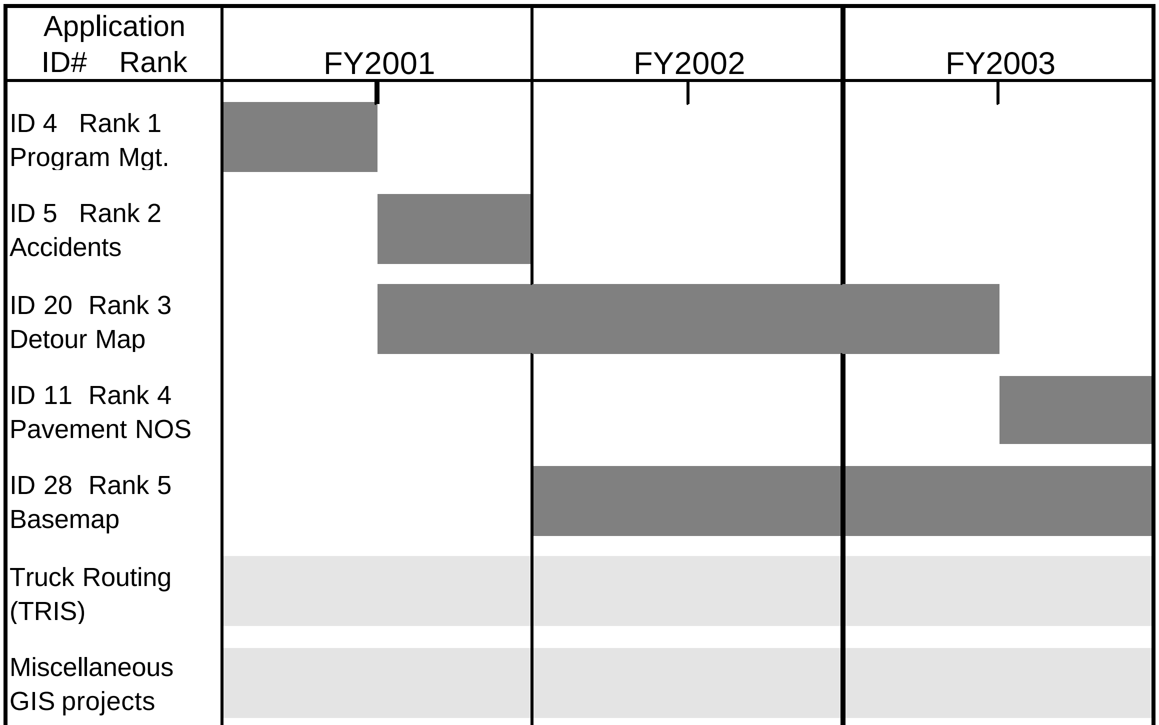
  - Current use
  - Importance
  - Relativity to CTP.

- Staffing adjustments were evaluated based upon the proposed projects. Three project teams are available for development of both new and ongoing projects.
- The GIS application development period was set as 2001-2003.
- Five (5) applications were recommended as having the highest priority for 2001-2003 implementation:
  - Decision maps (Program Management)
  - High accident location maps (Local Projects/Transportation Planning)
  - Construction and detours Web application (Construction and Maintenance)
  - Network Optimization Maps (Pavement Management)
  - Recompiled GIS basemap at 1:12,000 scale (Cartography).
- Five (5) applications were also recommended for implementation for 2001-2003, under a more aggressive implementation schedule:
  - GIS-Maintenance Management System (MMS) integration (Construction and Maintenance)
  - GIS-bridge inventory data integration (Local Projects)
  - GIS-Pavement Management Information System (PMIS) integration (Pavement Management)
  - GIS-traffic models integration (Statewide Planning)
  - Environmental use of GIS (Environmental Services)
- Nineteen (19) applications were identified that do not rank high enough to fit into the FY 2001-2003 schedule.

Two options for an implementation schedule and costs were generated:

Table 1 shows the implementation schedule and costs for fiscal years 2001-2003. This schedule assumes that, given the current staffing levels, three applications (including the Truck Routing Information System (TRIS) shown in a lighter shading) can be developed at a time, and only three applications can be achieved during any six-month period. The table also shows the ongoing efforts involved in miscellaneous GIS support services, though these services do not require a dedicated project team. The cost figures provided at the bottom of the schedule are for new applications only. Where an application is developed over two or more fiscal years, the costs have been apportioned out to each fiscal year.

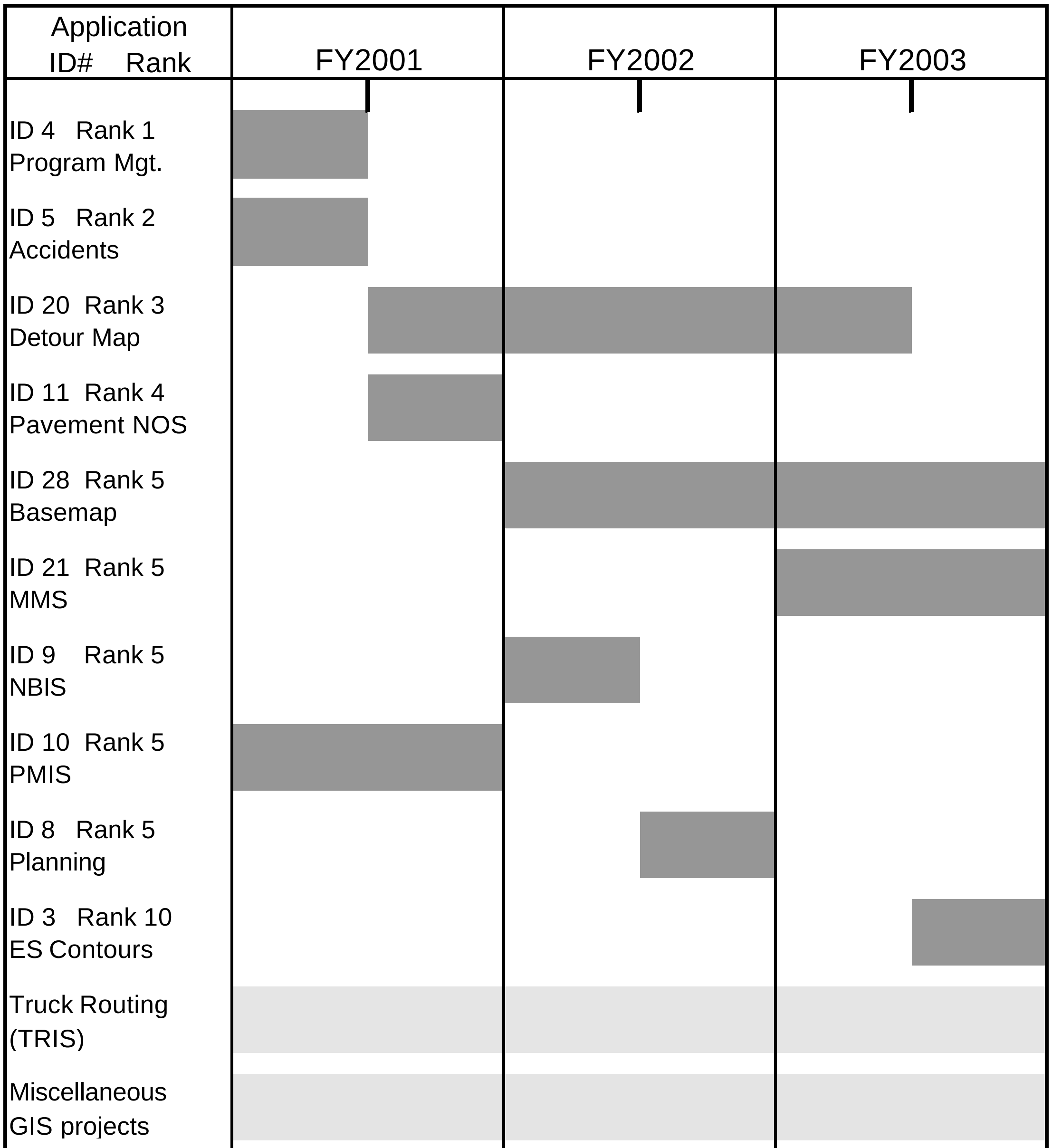
Table 1 – Implementation Schedule and Costs FY 2001-2003



Costs	FY2001	FY2002	FY2003
HW/SW	$ 15,000	$ 10,000	$ -
Data	$ -	$ 50,000	$ 25,000
Development	$ 145,000	$ 110,000	$ 187,000
Year Total	$ 160,000	$ 170,000	$ 212,000

Table 2 shows a more aggressive implementation schedule and costs for fiscal years 2001-2003. This schedule assumes that more than three projects can be tackled during any six-month period and results in more applications being rolled-out during the time period. This table again shows TRIS as an ongoing project, requiring the attention of a project team. The table also shows the ongoing efforts involved in miscellaneous GIS support services, though these services do not require a dedicated project team. The cost figures provided at the bottom of the schedule are for new applications only. Where an application is developed over two or more fiscal years, the costs have been apportioned out to each fiscal year. A miscellaneous cost is also shown, illustrating the costs of miscellaneous GIS activities and the TRIS project.

Table 2 – Aggressive Implementation Schedule and Costs FY 2001-2003



Costs			
HW/SW	$ 15,000	$ 10,000	$ 30,000
Data	$ -	$ 40,000	$ 65,000
Development	$ 403,000	$ 276,500	$ 299,500
Miscellaneous	$ 123,000	$ 176,000	$ 106,000
Total	**$ 541,000**	**$ 502,500**	**$ 500,500**

KDOT's GIS in the 21st Century

- The GIS Strategic Plan document should be reviewed annually and changes addressed and documented as part of a status reporting process and benchmarking of the GIS development process.
- The Plan project implementation period ends with FY 2003. A process to more formally revise, update, or replace the Plan should be implemented at that time.
- Technological issues that will affect GIS operations over the next few years include:
    - Advances in client-server technology
    - Advances in data storage technology
    - Use of GPS and field data collection technology.
- Organizational issues that will affect GIS operations over the next few years include:
    - How GIS will be placed in the KDOT organization
    - The role of GIS as an Agency-wide data integrator
    - Further definition of GIS customers.

Project Process

Project Direction

Background

The first GIS study for KDOT was completed in May 1995 and was followed in August 1995 with a study that set forth a definition for a KDOT standard GIS Location Reference System for data sets that were to be graphically displayed on the standard KDOT GIS basemap.

Plan Purpose

The purpose of the GIS Plan is to define and document the KDOT planned GIS direction for the next several years.

Project Mission

Update the GIS Directions Report that was developed in 1995, taking into consideration emerging technologies and new Agency needs particularly those of the new Comprehensive Transportation Program.

Project Goals

The following project goals guided the development of the GIS Plan during this update:

- Support the mission and objectives of the Agency
- Seek input and consensus on the Plan
- Prioritize GIS efforts and projects in an effective manner
- Recommend a GIS funding level sufficient to support proposed efforts
- Prepare for future GIS needs.

Project Participants

GIS Subcommittee

Paul Bodner	Bureau of Local Projects
Michael Carlyle	Bureau of Computer Services (BCS)
Gary Cox	Bureau of Right-of-Way
Roger Dahlby	Bureau of Transportation Planning (BTP)
Tom Eisenbarth	Bureau of Design
Marcia Ferrill	Division of Operations
Ken Gudenkauf	Bureau of Traffic Engineering
Allan Haverkamp	Bureau of Transportation Planning

Bill Haverkamp	Bureau of Design
Vicky Johnson	Office of Chief Counsel
Randy Leonard	Bureau of Design
Brian Logan, Chair	Bureau of Transportation Planning
Rick Miller	Bureau of Materials and Research
Gary Mutschelknaus	Division of Engineering and Design
Jaci Vogel	Bureau of Construction and Maintenance
Matt Volz	Bureau of Transportation Planning
Lynn Washburn	Bureau of Design
Stan Young	Bureau of Computer Services

GIS Strategic Plan Core Team Members

Brian Logan	BTP, Project Manager/GIS Coordinator
Nancy Mattson	BTP, GIS Project Manager
Michael Carlyle	BCS, Project Manager
Ken Bridges	Triple I, Consultant Account Director
Tony Pietropola	Geo Decisions, Project Manager
Don Kiel	Geo Decisions, Senior GIS Analyst
Chris Markel	Geo Decisions, Senior GIS Analyst
Jon Pollack	Geo Decisions, Senior GIS Analyst
Staff	Triple-I and Geo Decisions

(The GIS Subcommittee is an ITAC subcommittee and reports to ITAC.)

Agency Involvement

Agency involvement included in-depth interviews with GIS Subcommittee members and related staff. Additional interviews were conducted with specific workgroups and individuals involved in various information technology areas. GIS Subcommittee members and others reviewed and commented on the documents developed during the study.

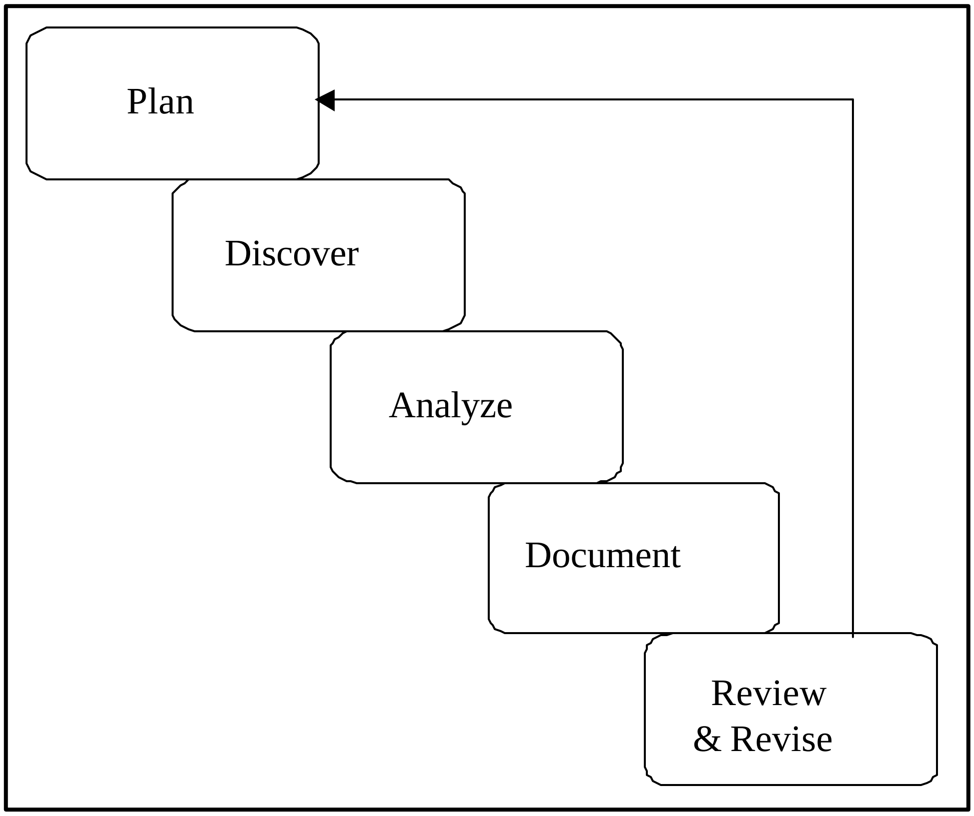
Project Plan

Methodology

Figure 1, on the following page, displays the methodology phases used to develop the GIS Plan.

Figure 1 - GIS Study Methodology Overview Chart

(adapted from 1999 ITA Plan)



Project Milestones

June 1998	Began researching other strategic plans
September 1998	Selected consultants for GIS strategic planning
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Management Plan

Agency Direction

Introduction

Information about the Agency's direction is outlined in the ITA Management Plan. The purpose of this information is to put in context the business environment directing the ITA Plan. The Agency Mission, Vision, Core Values, and Management Goals presented here have been developed by KDOT's Executive Committee. The Business Drivers, Enablers, and Inhibitors outlined were developed by the ITA Core Team and reviewed with the ITAC and across the Agency as part of this ITA Plan review process. They are the result of information provided in the KDOT Strategic Management Plan, Volume I, issued March 1995, and from information and impressions obtained during interviews with Agency management and technical personnel.

Agency Mission

To provide a statewide transportation system to meet the needs of Kansas.

Agency Vision

KDOT - the best in everything we do.

Agency Core Values

The following list outlines the core values as stated by the Agency:

- We are accountable to the people.
- We will continually improve.
- We will manage our resources wisely.
- Our employees are our most valuable resource.
- We depend on employees and business partners to get the job done.
- Our work environment will motivate people and encourage them to be productive.

Agency Strategic Goals

Agency Strategic Goals that support the accomplishment of the Agency Mission are:

- The Department will take the necessary actions to ensure the successful completion of the Comprehensive Highway Program.
- The Department will develop the parameters for the state's Comprehensive Transportation Program.
- The Department will have a positive influence on national actions relating to transportation.

- The Department will develop plans to accomplish its critical work more efficiently.
- The Department will optimize the use of technology to meet its business needs.
- The Department will improve its business practices by focusing its use of quality initiatives.
- The Department will develop performance measures that accurately reflect the Agency's critical success factors.

Agency Management Goals

The Agency Management Goals that support the accomplishment of the Agency Mission are:

- To provide the leadership necessary to enable the Department to effectively accomplish its mission.
- To efficiently plan a safe, effective, integrated, and practical transportation system that satisfies the needs of Kansas.
- To develop quality projects that effectively accomplish their purpose.
- To build a quality construction program.
- To efficiently maintain, as nearly as practical, a safe state highway system in its "as-built" or improved condition.
- To help local entities provide safe, efficient, and reliable transportation facilities and services.
- To provide the administrative support necessary to enable the Department to effectively accomplish its mission.

Agency Business Drivers

Internal and external considerations and events drive the business of the Agency. Those identified as most important in the coming years are:

Public and the Legislature. The needs of these groups of people determine programs and priorities.

New Comprehensive Highway Program. In 1998, all project lettings for the Comprehensive Highway Program were completed. In 1999, HB 2071 was passed by the Legislature and signed into law by the Governor to establish the new CTP that focuses on the ten-year period from FY 2000 through FY 2009. Potential projects, required by the new program, may require significant advanced planning and development efforts to bring new functionality on-line in time to support early program activities. The first official lettings of the new CTP are expected in July 1999. In the past, KDOT has substantially reduced plan development during times of funding uncertainty, and when funding did materialize, there was a shortfall of ready projects for as long as two to four years. Fortunately, the Agency has had the foresight to develop plan-production-only projects. This provides a supply of projects that can start very quickly with the advent of the new CTP since they may only need to be refreshed rather than started from scratch.

Federal Funding and Requirements. KDOT has been effectively utilizing the funds authorized by the TEA-21 Federal Highway Program to support continued improvement activities on the Kansas state highway system.

Staff Level Changes. There is continued pressure in government to reduce the level of full-time equivalent employees (FTEs). As the impact of these reductions continue, the Agency will be required to make some difficult choices as to the ability to perform at current levels. These choices will most certainly include discontinuing some current programs, improving the efficiency of others, and applying technology improvements to automate other processes. Invariably business process changes will have a major effect on IT since new application functions will be required to support the revised business processes. The following outlines specific initiatives that have or may affect KDOT staffing levels:

- 5 percent Workforce Reduction in FY96-97 – The Governor directed most state agencies to reduce their workforce by 5 percent in FY96 and FY97. KDOT lost approximately 55 positions during this reduction period.
- 3 for 4 Staff Retirement Program – In 1993, the Kansas Legislature passed legislation that requires all agencies to forfeit one of every four positions vacated by retirements. This is a continuing issue for KDOT.
- 10-Year CTP Staff Increase – The new CTP has authorized 108 new positions to accomplish the new program. This included six new IT positions within the Bureau of Computer Services and three IT positions for GIS in the Bureau of Transportation Planning

Privatization of Functions. KDOT has been a state leader in the privatization of functions by contracting many projects and tasks to private industry. KDOT has been moving in this direction through the outsourcing of contract programming, PC support, CAD support, and technology training efforts.

New Business Opportunities Driven by Rapid Technology Changes. A major purpose of the ITA Study is to identify technologies that may improve the way KDOT does business. Several examples of technologies that have come of age and are being aggressively studied by KDOT are GIS, Records and Workflow Management (RWM), Intelligent Information Systems (ITSs), and Internet/Intranet usage. Until recently these technologies were not technically feasible due to communications, hardware, software, and cost constraints.

GIS Direction

The development of this GIS Strategic Plan required information from all of the cooperating organizations and stakeholders, who may be involved with GIS. The process consisted of three primary means of information collection. The first method was the KDOT GIS Subcommittee kick-off meeting and Visionary Workshop©, which together provided a two-way flow of information. The second method was a series of direct interviews of KDOT staff by Geo Decisions personnel. The third method was the completion of proposed application templates for priority GIS applications throughout the Department.

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- Create a management structure capable of providing the planning, budget and implementation for an expanded GIS environment.
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- Promote and distribute GIS technology throughout the Department.

Critical Issues

Critical Issues can be defined as those major, broadly-defined areas or elements that must be addressed by specific actions to achieve GIS success. Three main Critical Issues were determined to be:

- Organizational Issues
- Basemap Issues
- Technological Issues.

Organizational Issues need to be addressed in terms of how GIS can support and be supported by the KDOT structure. To be considered successful, GIS must be accompanied by appropriate staffing levels, training and educational efforts, distribution and access to software and data, development of realistic, measurable goals, presence of a strong management structure, and development of pilot projects.

Basemap Issues are centered upon what resolution and other characteristics the "standard" GIS basemap will need to support desired uses. The basemap must allow translation and support of various linear reference measure schemes and accompanying data, historical data management and retrieval, and accommodation of GPS data.

Technological Issues involve determining and supporting appropriate GIS software, migration of data into true RDBMS, and provision of Internet and Intranet access to GIS maps and data.

Critical Success Factors

To be successful in meeting concerns associated with these issues, several Critical Success Factors were identified for each. This process was initiated through dissemination of a Critical Success Factors questionnaire to GIS Subcommittee personnel. Responses to the questionnaire provided background to perceived challenges at KDOT where GIS can make a difference. Critical success factors for GIS were then identified, proposed strategies and enhancements for GIS were documented, and specific performance measures for monitoring GIS success were collected. The questionnaire results were further refined through a more detailed review process. The Critical Success Factors are discussed in the sections below for each category of the critical issues.

Organizational Issues

Staffing Support. To support increased GIS usage, utility, and presence, increased staffing resources and options must be implemented. This process has already begun at KDOT, and should be supported into the long-range future. Demand for and successful delivery of GIS products is one indicator of the value of GIS in any organization. Corresponding support staff must be available to meet these demands. KDOT's CTP should be one vehicle that could justify funding of additional GIS staff. If appropriate personnel levels cannot be achieved, GIS success will lag.

GIS Distribution. As identified in interviews and questionnaire responses, "getting GIS out to the masses" will be a major factor in determining GIS success. This is likely to take the form of accessibility to Web-based GIS from the desktop for users throughout KDOT. Identification of how this is to be best achieved will be critical. This resulting implementation must be easy to use, yet sufficiently powerful to warrant significant use. The combination for successful deployment of GIS will result in realization of valued applications and benefits through a well-designed interface that becomes utilized as a course of daily business functions.

Training and Education. Training and education opportunities for GIS staff and outside personnel must be provided. Supporting GIS properly means developing in-house GIS unit expertise in application of the appropriate tools. This empowerment also requires corresponding efforts at training and educating other KDOT personnel, from technical GIS users to managers and administrators. A less technical approach is needed for the latter group, with emphasis placed upon education of what GIS is and how GIS can help various business unit work functions. Realization of GIS usage is equal parts demand for and supply of products. Emphasis must be placed on both aspects.

Data Access and Sharing Improvements. To accomplish the distribution of GIS at the desktop level, corresponding improvements must be made to provide access to data that can be analyzed with GIS. Access to the CANSYS II database and other databases through GIS must be efficiently provided. Errors in data must also be detected and fixed to assure confidence in usage. GIS can help as a validation, analysis, and visualization tool.

GIS Management Structure. Strengthened management support structures will be needed to support increased usage of GIS. The present GIS Subcommittee may need to be reworked in structure or membership. New members could include those who are currently uninformed about GIS but who may have extensive potential for its use. This would especially include "external" individuals outside the current GIS group. Also, key individuals who may be skeptical or negative toward GIS could be considered for membership if they can approach the group in an open-minded manner. At times, this type of member can provide "reality checks" for GIS if offered with a well-intentioned approach. In turn, such individuals may be more receptive to GIS if made an informed part of the group. Members need to be continually educated, energized, and made a valuable portion of the GIS support structure. These members should be the most important customers of GIS, and can help to sustain momentum and upper management support. Similarly, the GIS unit managers must efficiently manage and coordinate GIS at a level appropriate to available resources and not try to accomplish too much too soon.

Development of Realistic, Measurable Goals. As mentioned above, constructing and following a realistic game plan is absolutely necessary for GIS success at KDOT. There is always a danger of trying to accomplish too many things too quickly with GIS. Success requires great patience in data development, provision of access to GIS, programming of new applications, and expansion of capabilities to new users. Identification of reasonable, timely, achievable actions is a major step in sound GIS program development. Scheduling and pacing actions require careful thought. In many cases, identifying a short-term pilot project(s) to demonstrate GIS value is appropriate.

Basemap Issues

Basemap Resolution. Selection of a new, revised "standard" basemap for GIS use will greatly affect the rest of the Agency. The nature of the map layer will be influenced by several factors. Scale of the final product depends upon the currently used products, basemap layers used by others around the state, and the needed resolution of application-related uses (such as GPS-collected data). Work planned or already underway must be incorporated, such as addition of all functionally-classified roads through minor collectors. Incorporation of local roads is also desired. Piecing together the final product will define how many of its uses and applications will be structured.

Data/LRS/Route System Translators. To be used with the GIS basemap, non-graphic databases must be accessible in a common format. In most cases, data relating to the transportation network will be described through some type of location reference method (LRM), e.g., milepost, segment-offset, latitude/longitude, etc. KDOT's GIS must be able to successfully access and/or translate graphic and non-graphic elements. Data in different database formats must be accessible and be able to be integrated for GIS use. Graphic locational element references must be able to be translated so that data collected via disparate methods can be seamlessly compared, viewed, and analyzed. Different LRMs must be able to be translated through a linear reference system (LRS) for use in other GIS software and to a format that can be distributed widely to users across the state.

GPS Accommodation. A special type of LRM merits attention for GIS. Global Positioning System (GPS) field data collection can yield highly precise coordinates for GIS use. The basemap resolution affects and is affected by GPS issues, and the potential to improve GIS basemap resolution through collection of GPS coordinates is considerable.

Historical and Temporal Data Management. KDOT must currently keep separate historical database snapshots to support historical data analysis and query. A more efficient method is needed to support and manage this type of information.

Technological Issues

Software Choice. The current state of the GIS software market is always difficult to pin down. Rapidly changing computer technologies influence new developments and directions in GIS. New developments with Intergraph's GeoMedia desktop GIS product, for example, mandate that KDOT should wait for the release of version 3.0 before distributing GIS to desktops around the Department. Also, the new generation of object-oriented spatial database management systems may offer better solutions to storage of GIS map and data elements. The timing for GIS deployment needs to be carefully considered in light of expected software developments.

Data Migration to RDBMS. To be efficiently used with GIS, data must be effectively available through an RDBMS. Completion of the CANSYS II system will greatly facilitate such GIS access. Additional data must be made similarly accessible through comparable database structures.

Development of GIS Pilot Projects. A quick rollout of successful GIS often requires performance of one or more pilot projects. The utility and effectiveness of GIS can be demonstrated quickly, at relatively low cost and effort, and in a highly visible manner. Inclusion of a pilot phase for major projects or applications is usually wise. This is often the key to obtaining continuing support of high-level management for GIS. Several initiatives and units in KDOT have current or projected management systems projects that could incorporate GIS. Consideration of these projects as GIS pilot applications may be appropriate.

Internet Access to GIS Data. There is strong demand for provision of GIS data outside of KDOT (to the general public and others) through Internet delivery mechanisms. As an example, viewing of GIS maps and data for the CTP would be highly desirable. Methods to make these products and others available over the Internet will need to be designed and developed.

Intranet Access to GIS Data. Complementing general Internet access to GIS will be dissemination of GIS data within KDOT via a secure Intranet structure. The current Road Condition Reporting System (RCRS) project is representative of the type of project in which GIS can play a central role. Pending development of a construction and detour reporting system is another project of a similar nature. KDOT district offices will be especially suitable for connection and use of GIS in conjunction with Internet access.

Strategic Objectives, Strategies and Action Plans, and Performance Measures

Critical Success Factors can be further considered by setting related Strategic Objectives, Strategies and Action Plans, and Performance Measures. These elements will help to further define and refine what work can be performed to ensure GIS success at KDOT. Setting an objective helps to clearly focus on what is to be done; strategies and actions help to define how to perform the work; and performance measurements help to gauge how successful the effort was/is. Each section below provides summary information on how the critical success factors can be approached in this manner. **Table 3**, Time Line of Activities, on the next page, provides a summary of activities and when they should occur.

Staffing Support

Strategic Objective: Provide appropriate GIS staffing levels to support expanded operations throughout the Department.

Strategies and Action Plans:

1. Utilize available funding resources through the CTP.
2. Explore cooperative funding with other KDOT departments, including district offices.
3. Continue use of open-end contract support and/or contract on-site GIS support personnel.
4. Consider employment of student/intern GIS support personnel.

Performance Measures:

1. Fill currently open GIS position vacancies by the First Quarter 2000, and monitor opportunities for additional personnel hiring subject to current personnel freeze.
2. Maintain contract support mechanism(s) in place.
3. Hire at least one GIS student intern on an experimental basis for the Third Quarter of 2000.

Table 3 – Time Line of Activities

WORK TASK	YEAR 2000				YEAR 2001				YEAR 2002			
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Fill Open GIS Positions	■											
Hire One GIS Student Intern on an Experimental Basis			■									
Design Plan for Deployment of Desktop GIS		■										
Geo Media 3.0/GeoMedia Web Map Evaluation		■										
Develop and Deploy Initial Desktop GIS Software/Tools				■								
Deploy GIS in the Initial District Office							■					
Conduct One Non-technical GIS Seminar												
Provide Software Training for New GIS Personnel			■									
Conduct a Series of Three Technical GIS Seminars				■								
Staff Attend One National/Regional/State GIS Conference				■				■				■
Develop & Publish a Regular GIS Status/Newsletter Report	■											
Develop Intranet Site			■									
Prepare and Distribute GIS Capabilities & Service Brochures				■								
Prepare Various GIS Presentations				■								
Complete Design Plan for GIS Data Structure and Access			■									
Develop GIS Access to CANSYS II				■								
Develop GIS Access to at Least One New Data Source Annually				■				■				■
Design and Deploy at Least One GIS Tool to Promote Data Error Detection/Correction				■				■				■
Develop a GIS Management Plan & Define GIS Organization	■											
Establish a Regular GIS Subcommittee Meeting Schedule	■											
Develop a GIS Product Tracking Mechanism/Report	■											
Complete Annual GIS Action Plan	■				■				■			
Have GIS Subcommittee Review/Revise GIS Action Plan Quarterly	■	■	■	■	■	■	■	■	■	■	■	■
Complete Standard Basemap In-house Study & Evaluation		■										
Complete Basemap Conversion Pilot Test				■								
Complete Federal and Local Road Additions Pilot Test						■						
Complete Entire Basemap Layer										■		
Complete LRM Inventory	■										■	
Complete Database Inventory			■									
Complete Evaluation Study of Object-oriented Database Software				■								
Complete LRS/LRM Data Translation Project						■						
Complete GPS Use Inventory	■											
Complete GPS/GIS Conversion Project				■								
Complete Identification and Documentation of Historical/Temporal Data Sources				■								
Complete Historical/Temporal Management Design Plan					■							
Develop and Deploy GIS Historical/Temporal Data Access/Retrieval/Display							■					
Perform GIS Software Eval. in Conjunction with Project Design/Development												
Complete Evaluation of Object-oriented Spatial Database Products					■							
Complete Database Migration/Integration Plan			■									
Initiate Migration of Data				■								
Complete List/Scope Document for Potential Internet GIS Applications		■										
Complete Internet Pilot Project			■									
Complete List/Scope Document for Potential Intranet GIS Applications		■										
Complete Intranet Pilot Project				■								

Staffing Support	■	■	Data/LRL/Route System Translators
GIS Distribution	■	■	GPS Accommodation
Training & Education	■	■	Historical and Temoral Data Management
Data Access & Sharing	■	■	Software Choice
GIS management Structure	■	■	Data Migration to RDBMS
Development of Realistic, Measurable Goals	■	■	Development of Pilot Projects
Basemap Resolution	■	■	Internet Access to GIS Data

GIS Distribution

Strategic Objective: Provide widespread hands-on access to GIS functionality, maps, and data throughout KDOT.

Strategies and Action Plans:

1. Formulate a detailed design plan document for development and deployment of desktop GIS throughout KDOT. Include interviews, available hardware, software, and communications networks analyses, potential applications needs, database considerations, and scheduling and phasing for implementation. This process should provide additional detail to supplement recommendations and conclusions presented in this strategic plan document, and be updated and revised continually to meet dynamic needs and requirements.
2. Evaluate GeoMedia version 3.0 for appropriate applications to KDOT's GIS needs.
3. Following the design plan, develop and deploy simple-to-use standard desktop GIS tools and interfaces for general GIS queries, viewing, data validation, and analysis throughout KDOT Central Office.
4. Deploy desktop GIS at KDOT district offices.

Performance Measures:

1. Complete design plan for deployment of desktop GIS by Second Quarter 2000.
2. Complete GeoMedia 3.0/GeoMedia Web Map evaluation by Second Quarter 2000.
3. Develop and deploy initial desktop GIS software/tools in at least one KDOT Central Office department by Fourth Quarter 2000.
4. Deploy GIS software/tools in at least one KDOT district office by Third Quarter 2001. This should be coordinated as much as possible with existing and proposed management system deployments such as RCRS, Construction and Detour Routing System (CDRS) and TRIS. Provision of GIS interface tools to these programs should be promoted.

Training and Education

Strategic Objective: Provide appropriate vendor-conducted and in-house GIS training and education for KDOT personnel.

Strategies and Action Plans:

1. Conduct in-house educational seminars targeted towards mid-level KDOT departmental managers. These would be non-technical and oriented around promotion of potential GIS uses. Federal Highway Administration (FHWA) support for training should be sought, especially in conjunction with development of the new FHWA Regional Resource Centers.
2. Provide expanded vendor training on GIS software for in-house GIS personnel. Types of training would be matched specifically to personnel functions and project needs, and include beginning to advanced GIS, programming, database management, etc.

3. Provide in-house technical "cross-training" seminars and applications demonstrations for departmental GIS personnel, including district offices. Such training should primarily spread core GIS staff knowledge and expertise to new users.
4. Encourage GIS staff to attend national/regional/state GIS conferences that provide opportunities to learn more about GIS-T and GIS development issues. Give presentations on KDOT GIS when possible.
5. Develop and disseminate in-house GIS marketing initiatives, including as possibilities are a status report/newsletter, Intranet site, and various printed and/or computer presentations.
6. Provide additional GIS educational materials for KDOT management.
7. Consider involvement in national cooperative initiatives for GIS-T through channels such as pooled fund studies, standards design and testing, and data exchange programs.

Performance Measures:

1. Conduct one non-technical GIS seminar (repeated as needed) for KDOT departmental managers by Fourth Quarter 2000.
2. Provide software training for new GIS personnel by Third Quarter 2000.
3. Conduct a series of three technical GIS training seminars at KDOT's Central Office and at one pilot district office by the end of 2000.
4. Staff to attend at least one national/regional/state GIS conference annually.
5. Develop and publish a regular GIS status report/newsletter with a First Quarter 2000 startup date; develop Intranet site by Third Quarter 2000; prepare various GIS presentations by Fourth Quarter 2000. GIS updates could also be featured in the KDOT and BSC newsletters.
6. Prepare and distribute GIS capabilities and services brochures and similar materials by end of 2000.

Data Access and Sharing Improvements

Strategic Objective: Improve GIS access to KDOT transportation databases for decision support, visualization, analysis, and data error detection purposes.

Strategies and Action Plans:

1. Formulate a design plan for GIS database structures and access.
2. Following completion of the design plan, provide direct GIS access to the CANSYS II database.
3. Provide direct access to other useful data sources such as Kansas Accident Record System (KARS), maintenance data, and bridge data.
4. Provide GIS tools to promote data error detection and correction.

Performance Measures:

1. Complete design plan for GIS database structures and access by Third Quarter 2000.
2. Develop GIS access to CANSYS II when the latter system is implemented.
3. Develop GIS access to at least one additional data source annually beginning in 2000.
4. Design and deploy at least one GIS tool to promote data error detection and correction by Fourth Quarter 2000.

GIS Management Structure

Strategic Objective: Develop a strengthened core GIS management structure, supported by increased involvement of GIS Subcommittee members and other departmental representatives.

Strategies and Action Plans:

1. Define and clarify overall GIS management roles and responsibilities in the core GIS unit.
2. Commit GIS Subcommittee members to more frequent and deeper involvement with GIS.
3. Commit GIS staff to more involvement with GIS Subcommittee members and their business processes. This is an important aspect of GIS outreach, and helps to ensure participation of personnel from other units in GIS processes.
4. Track GIS "products" provided to units. Initially, this will most often be in the form of hardcopy maps. This will assist in helping to decide which units will best be supported and involved with GIS.

Performance Measures:

1. Develop a GIS management plan and defined organizational structure for the core GIS unit by First Quarter 2000.
2. Establish a regular GIS Subcommittee meeting schedule with set agendas, informative non-technical presentations, and other educational content. Settle upon a workable and effective meeting frequency that is neither too burdensome (too often) or too infrequent or irregular. Begin this schedule by the beginning of 2000.
3. Develop a continually updated GIS tracking product mechanism/report by the beginning of 2000.

Development of Realistic, Measurable Goals

Strategic Objective: Determine and document realistic, measurable goals for GIS operations for the next one to two years.

Strategies and Action Plans:

1. Develop a specific GIS action plan to meet goals and objectives for GIS for the next one to two years. Ensure consistency with the broadly-defined GIS vision, mission, goals, and objectives as defined earlier, and with KDOT Agency goals and objectives. Receive guidance and direction from the GIS Subcommittee. Schedule and categorize milestones to be achieved for software/hardware/networks deployment,

application development, database access, management, etc. Input to the plan will be taken from other plan processes and documents to be developed in other strategies/action plans work. Above all, realism is needed as to what can be accomplished with available time and resources.

2. Emphasize small, affordable "modules" for development of GIS applications/projects. Input already received from potential users (primarily members of the GIS Subcommittee) will form the basis for these projects.
3. Establish an oversight function for implementation of GIS actions, applications, and projects with the GIS Subcommittee.

Performance Measures:

1. Complete GIS action plan process by First Quarter 2000.
2. Have GIS Subcommittee review/revise GIS action plan at least quarterly as part of regularly scheduled meetings.

Basemap Resolution

Strategic Objective: Design and construct a new, revised "standard" GIS basemap layer at 1:12,000 or more detailed scale for general KDOT application use.

Strategies and Action Plans:

1. Perform an in-house study and evaluation to define characteristics of the standard basemap layer. Solicit input from within KDOT and from outside interests such as DASC.
2. Evaluate and accommodate requirements and implications of basemap conversions between Intergraph format and other formats (particularly ArcView and TransCAD). Document conversion needs, design conversion methodologies, and perform a pilot conversion testing project.
3. Explore available sources for addition of local and federal roads into the standard basemap layer. Design and perform a pilot project to add local roads for a chosen area to the basemap, including linear referencing structures.
4. Develop complete standard basemap layer.

Performance Measures:

1. Complete standard basemap in-house study and evaluation by Second Quarter 2000.
2. Complete basemap conversion pilot test by Fourth Quarter 2000.
3. Complete federal and local roads addition pilot test by Second Quarter 2001.
4. Complete entire basemap layer by Second Quarter 2002.

Data/LRS/Route System Translators

Strategic Objective: Provide mechanisms to translate GIS graphic location references seamlessly among multiple LRMs and among multiple database formats.

Strategies and Action Plans:

1. Inventory and document the various LRMs in use at KDOT and in relevant outside agencies.
2. Inventory and document useful and needed databases and formats that have locational referencing.
3. Evaluate new object-oriented database software for applicability to location referencing conversion processes.
4. Conduct LRS/LRM data translation design and development project.

Performance Measures:

1. Complete LRM inventory by First Quarter 2000.
2. Complete database inventory by Third Quarter 2000.
3. Complete evaluation study of object-oriented database software by Fourth Quarter 2000.
4. Complete LRS/LRM data translation project by Second Quarter 2001.

GPS Accommodation

Strategic Objective: Provide the ability to accommodate and translate between GPS-collected field data formats and standard GIS linear referencing and basemap formats.

Strategies and Action Plans:

1. Inventory and document existing and potential GPS uses for field data collection throughout KDOT.
2. Test GPS/GIS graphics and data conversions through a pilot project. Candidate projects could be field collection of entrance locations for access permits, or location of Intelligent Transportation Systems (ITS) field elements. Accuracy comparisons and linear “matching” should be evaluated.

Performance Measures:

1. Complete GPS use inventory by First Quarter 2000.
2. Complete GPS/GIS conversion project by Fourth Quarter 2000.

Historical and Temporal Data Management

Strategic Objective: Develop tools to support and manage retrieval and analysis of historical/temporal GIS map graphics and related data.

Strategies and Action Plans:

1. Identify and document needed historical/temporal map and data sources.
2. Formulate a design plan document for retrieval and management of historical/temporal maps and data elements. Include definition of update cycles needed, length of historical records required. Implement changes to database structures as needed. Evaluate and support additional data storage requirements.
3. Develop GIS map/data tools to support retrieval, display, and analysis of historical/temporal data.

Performance Measures:

1. Complete identification and documentation of historical/temporal data sources by Fourth Quarter 2000.
2. Complete historical/temporal management design plan document by First Quarter 2001.
3. Develop and deploy GIS historical/temporal data access/retrieval/display/analysis tools by Third Quarter 2001.

Software Choice

Strategic Objective: Evaluate state-of-the-art software for relevance in making improvements to KDOT's existing GIS operations.

Strategies and Action Plans:

1. Perform evaluation of state-of-the-art GIS software products to determine future courses of action for upgrading/changing current software. Implement changes as identified to best support priority GIS applications (which may begin as pilot projects).
2. Perform evaluation of state-of-the-art spatial database software products to determine suitability of application to KDOT GIS operations. Storage of spatial data in mainstream RDBMS databases may provide better data management for the Department and faster access to data for multiple users. Products such as Oracle Spatial allow storage of GIS data directly in the database instead of in a separate file-based structure. Oracle tools can then be used to manage the data. In addition, the development of object-oriented databases (OODBMS) or object-oriented structures within RDBMS may provide benefit to GIS operations as GIS software vendors explore object-oriented approaches. Implement changes as needed.
3. Perform evaluation of "peripheral" software products for relevance of application to KDOT GIS operations. These applications could include software for digital orthophotography, document management, videolog display, 3-D visualization, real-time modeling, and raster analysis. Implement new applications as needed.

Performance Measures:

1. Perform GIS software evaluation in conjunction with design/development phase of each priority application or pilot project.
2. Ensure compatibility of state GIS standards for software when possible.
3. Complete evaluation of object-oriented spatial database products by Fourth Quarter 2000. Implement changes by First Quarter 2001.
4. Perform evaluation of peripheral software at least quarterly as part of GIS Subcommittee meeting action plan review process.

Data Migration to RDBMS

Strategic Objective: Migrate and integrate KDOT databases for GIS use through an RDBMS. Database conversion projects that are being converted to RDBMS format as part of other KDOT management systems initiatives should be reviewed and coordinated with GIS efforts to ensure consistency and usability for GIS.

Strategies and Action Plans:

1. Build upon results of database inventory and CANSYS II project. Develop database migration/integration plan.
2. Construct RDBMS compatible with GIS use.

Performance Measures:

1. Complete database migration/integration plan by Third Quarter 2000.
2. Initiate migration of data beginning in 2000.

Development of GIS Pilot Projects

Strategic Objective: Identify and promptly develop suitable GIS pilot projects to demonstrate GIS utility and worth.

Strategies and Action Plans:

1. Identify appropriate types and locations for GIS pilot projects. Work should be of sufficient brevity to result in short implementation time, yet meet a demonstrated need or application. Such projects should involve another KDOT department and a district office if feasible. The actual number of pilot projects will be dependent upon available resources. Candidate projects include a GIS interface to viewing the CTP, a project tracking map/visualization tool and an Internet- or Intranet-accessible application for a district office. Demonstration of these projects to upper-level management should be performed.

Performance Measures:

1. Complete at least three GIS pilot projects annually, beginning with the year 2000.

Internet Access to GIS Data

Strategic Objective: Provide a simple-to-use but powerful Internet GIS application for widespread access by KDOT and external users.

Strategies and Action Plans:

1. Develop a list and scope document for potential Internet GIS applications. Include time and cost estimates to develop.
2. Design and develop an Internet GIS pilot application. Possible candidate is CTP viewing interface. Consider involvement with RCRS, CDRS, and TRIS projects as appropriate.

Performance Measures:

1. Complete list/scope document for potential Internet GIS applications by First Quarter 2000.
2. Complete Internet GIS pilot project by Third Quarter 2000.

Intranet Access to GIS Data

Strategic Objective: Provide a simple-to-use but powerful access-controlled, secure Intranet GIS application for internal KDOT use.

Strategies and Action Plans:

1. Develop a list and scope document for potential Internet GIS applications. Include time and cost estimates to develop.
2. Design and develop an Intranet GIS pilot application. Possible candidate is a project tracking interface. Consider involvement with RCRS, CDRS, and TRIS projects as appropriate. Evaluate possibilities for coordination with Advanced Traveler Information Systems (ATIS) projects from ITS initiatives, which may also be provided over Internet public access.

Performance Measures:

1. Complete list/scope document for potential Intranet GIS applications by Second Quarter 2000.
2. Complete Intranet GIS pilot project by Fourth Quarter 2000.

Priority GIS Projects

Applications Overview

A total of 29 Application Templates were received. The following are brief descriptions of each application. The number before each description is the ID number of the Application Template, assigned in the order Application Templates were received.

1. The Bureau of Traffic Engineering is interested in an application that would allow them to graphically view and query all pertinent information relating to the approval/denial of driveway permit applications throughout the state. For a given highway segment they would like to overlay information regarding existing driveways, geometric data, accident and vehicle counts, and videolog information. In addition to serving as a decision support tool for reviewing permit applications, it will also serve as an aid in the inventory of entrances on the state highway system.
2. The Environmental Services Section (ESS) is interested in an application to track projects relating to ESS field reviews, clearances and permits. They would like to integrate their existing database with KDOT's road and bridge data. They would require CANSYS II and Comprehensive Program Management System (CPMS) databases along with scheduling information and changes for current projects. This application would allow ESS staff to minimize duplication of efforts in data entry and prioritize projects from the start.
3. Environmental Services Section would like to have the ability to integrate KDOT's MicroStation DGN files with ArcView to view construction layouts and contour maps in reference to various environmental data. The GRID and TIN modules of the ARC/INFO software, or Spatial Analyst and 3D Analyst extensions to the ArcView software will be needed for manipulation of current data.
4. The Bureau of Program Management (BPM), in conjunction with the Cartography Unit in the Bureau of Transportation Planning, makes maps that assist decision-makers in the selection and legislative approval of KDOT's CTP. BPM prefers to keep all maps in hardcopy format,

although they stated that GeoMedia would be useful in reading and modifying files as they were created. They currently use CANSYS and a Lotus database, but need an LRS component.

5. The Bureau of Transportation Planning, Geometric and Accident Unit needs an application that would allow them to analyze and spatially display high accident locations. This information would be used by the Department to define and implement countermeasures which impact highway safety and by law enforcement agencies for resource allocation. In addition, this application would supply critical information to the project priority formula.
6. The Bureau of Local Projects is interested in having an Internet application to view existing maintenance agreements on a statewide basis. They have an Access database to handle GIS attributes. They would require county logpoint data, state highway description/location data, and location of frontage/access roads from the six district offices.
7. The Bureau of Local Projects is interested in mapping accident locations throughout the state to help them distribute Federal Funds to local agencies. They would like to GPS accident locations to use in conjunction with KARS.
8. The Statewide Planning Unit would like to develop a transportation-specific application that would capture census and other demographic data and link it to routing features to analyze shortest distance zones. This would enable the Unit to provide traffic-forecast models and visualization tools to Metropolitan Planning Organizations. This application would not be for public use, but rather used only by personnel in the unit. The application would produce hardcopy maps to be used for analysis. Access would be needed to Automated Traffic Recorder System (ATRS), Coverage Counts/Traffic Systems Database (CVRG), and CANSYS II. They would also need route distance log and the Videolog basemap.
9. The Bridge Inspection Unit of the Bureau of Local Projects is undergoing an effort to establish a bridge inventory in the state. They need National Bridge Inventory (NBI) Data from FHWA and Local Projects NBI Data. The application is in the planning stage and began development in the Fourth Quarter of 1999. They plan to incorporate GIS information with this application.
10. The Pavement Management Section of the Bureau of Materials and Research has developed a PMIS. This system integrates their Network Optimization System (NOS) and Project Optimization System (POS). Presently, the PMIS is used to generate reports and maps relating to specific NOS and POS data. The Unit would like to use these maps interactively, i.e., click on a part of the map and get all relevant data needed to assist in their decision-making.
11. NOS is a survey of the state highway system to obtain information about the pavement surface. This is followed by an optimization procedure that predicts the need for pavement rehabilitation. The final products are survey maps and candidate project maps for each district. They would like to use GIS to automate the process.
12. POS involves data collection and analysis at selected project locations to help determine the most appropriate design/action. Currently, the POS process results in listings of alternative scopes for each project. They would like to be able to produce maps and take a computer on the road to better assist the decision-makers.
13. The ITS Unit of the Bureau of Transportation Planning is interested in a database and graphical representation of cellular coverage throughout the state. This will assist them in

determining where additional cellular coverage is needed. Data collection is required to obtain GPS point locations of tower sites.

14. The ITS Unit of the Bureau of Transportation Planning is in the process of developing an Advanced Traffic Management System for the Kansas City Metropolitan Area. This system is controlled by a central Traffic Operations Center (TOC). In the TOC there will be graphical displays of the location and status of all field elements and a means to control these elements via the graphic interface. They want to insure that their parameters are synchronized with KDOT policy, procedures, standards, and guidelines.
15. The ITS Unit of the Bureau of Transportation Planning needs a database and graphical representation of the telecommunications infrastructure that KDOT owns, leases or has rights to. They need to maintain past, present and future communication services. This could include the cellular network coverage area that is also requested by the unit, as well as utilities such as fiber optics. They would need to GPS the locations of towers and lines.
16. The ITS Unit of the Bureau of Transportation Planning is in the process of developing an Advanced Traffic Management System for the Wichita area. This system is controlled by a central TOC. In the TOC there will be graphical displays of the location and status of all field elements and a means to control these elements via the graphic interface. The purpose of this is to give the operator control over all field elements on the freeway management system. They will need the baseline freeway system.
17. The Signing Section of the Bureau of Traffic Engineering is interested in developing a sign inventory management system. They envision creating a bar code for each sign on the highway system and using this code to track and manage conditions and locations of signs. They would like to GPS locations of present and future sign locations and have the ability to map and view these locations graphically.
18. Traffic and Field Operations would like the ability to create maps showing traffic count and Average Annual Daily Traffic (AADT) data along the state highway system. Currently the maps are produced manually.
19. Traffic and Field Operations would like the ability to create and use maps showing traffic count locations and AADT data. This effort could be a result of previous requests for more accurate and more accessible traffic count data by other departments. Currently the Department collects traffic data statewide manually. They would like the ability to allow field personnel to enter information directly into an electronic map and database.
20. Construction and Maintenance would like to develop a Web-enabled GIS application for Construction and Detour. This application would give field offices the ability to report construction and detour information via the KDOT Intranet. They would like a map interface to be connected to an Oracle database that stores all the data relating to present and planned construction activities. This will be an aid to the truck routing application also being developed by the state which plans and routes heavy or wide loads. It is expected that all persons internal to KDOT and the general public will access this application. Data to be displayed will include the activity start and end date, location, type of activity, number of lanes, description, etc. Reference markers will be used to define location, so these markers will have to be translated to KDOT’s Route-County-Logpoint referencing system. They would like this to be a live Internet application.
21. Currently, the Construction and Maintenance Bureau maintains a DB2 mainframe database referred to as the MMS. It contains data about various maintenance activities on road

segments throughout the state. The Bureau would like to be able to make decision maps from the data in the MMS. The MMS uses reference markers, which would need to be tied to the Route-County-Logpoint reference for on-the-fly map production.

22. The Construction and Maintenance Bureau is developing a Quality Assurance (QA) application for the highway system. The purpose of this application is to give decision-makers a more effective method of rating and prioritizing maintenance activities. This application will be an extension of the MMS and therefore will likely be a DB2 database. A link between the QA and MMS application will need to be established. The end product of this application will be decision support maps.
23. The Construction and Maintenance Bureau is interested in an automated means of scheduling and routing snow plowing activities. This would be accomplished by using various data throughout the state and field offices. CANSYS II and Winter Index Information will be the most useful of the existing data. They would like this to be an Internet application with live update.
24. The Construction and Maintenance Bureau is interested in developing a database for entering maintenance activities. This process would be especially useful during adverse weather conditions and late night repairs where supervisors are not always available to report activities. They would like this application modeled after the RCRS application. This would also be useful in the future for accessing past maintenance activities. Data entry would be dynamic, allowing the staff to enter in any relevant information. GeoMedia Web Map was suggested as a possible interface.
25. The Construction and Maintenance Bureau is interested in having a GIS interface with their legacy databases. Presently, information from these databases is presented as reports, not maps. It would be useful to field staff to be able to query and map this data. They would like some predefined queries and maps from GeoMedia Web Map and some ad-hoc queries and maps produced in GeoMedia.
26. The Cartography Unit would like the ability to automate their county map inventory. Currently, they use CADD to update their maps every seven (7) years with changes to houses, schools, churches, etc. They would like to have a red-lining capability with a GIS tool to access county DGN files to update their maps. This would allow them to update their maps more frequently, possibly using GPS to collect new site locations. Symbols used now in CADD would have to be converted to GIS symbols.
27. The Cartography Unit maintains construction strip maps for all sections of road on the Kansas Highway Network in CADD format. These maps contain the highway's pavement history. They are planning to convert this to a data driven application with the capability for GIS reporting and mapping. They would like to view this application via GeoMedia Web Map.
28. The Cartography Unit maintains a basemap of the 10,000 miles of state roads at a map scale of 1:24,000. In order to become consistent with statewide GIS initiatives, provide additional map accuracy (especially important for incorporation of GPS), and serve more KDOT GIS applications, the basemap must be re-compiled using the statewide 1:12,000 scale digital orthophotos and include all road features. Additionally, the basemap should be made compatible for use in Intergraph GeoMedia and MGE products, ESRI ARC/INFO and ArcView products, TransCAD software, CAD programs, and satellite imagery. This re-working of the GIS basemap occurs in two phases. This application is the first phase and

involves the re-compilation of the existing state road system and the addition of 34,176 miles of FHWA Functional Classification roads through minor collector.

29. This is the second phase of the re-working of the Cartography Unit's GIS basemap. In order to accommodate new GIS applications and share data with other Kansas GIS programs, the 99,360 miles of local roads in the state need to be added to the basemap. Additionally, a location referencing method must be applied to the local roads, to accurately map features along these roads (e.g. accident locations). This application is the work required to add these roads to the basemap.

Analysis Tables

Each application was evaluated for the level of effort it would take to develop, what data may have to be collected, how the application might be used and how often, and how important the application was to KDOT and Transportation Program needs. Tables were designed to aid in the analysis of the applications. These tables were produced to aid in estimation of application costs and effort, and in ranking and prioritizing the applications.

Time and Cost Estimate Table

High level estimates of cost and time were developed for each application. These estimates reflect effort that must be expended to develop the application design, program(s), and documentation, generate data needed for the application, and any hardware and software products specifically required for the application. The following are descriptions of each column in **Table 4**:

1. ID number of the application.
2. Cost of Data Development, in dollars. This cost is derived from column 6, with $75 an hour used for each hour in column 6.
3. Cost of Application Development Effort, in dollars. The cost is determined by using $150 an hour for each hour noted in columns 5, 7, and 8.
4. Cost of Hardware and Proprietary Software Purchases, in dollars.
5. Consultant Time for Implementation, in hours. This includes time spent designing the application, programming, developing tables and translating databases, testing, and implementation.
6. Consultant Time for Data Development, in hours. This includes time spent collecting field data, modifying data such as the GIS basemap, or data entry.
7. System Documentation. Consultant time in hours to document system for later maintenance and enhancement efforts.
8. Users Guide. Consultant time in hours to document how to use the application.

Table 4 – Time and Cost Estimates

1. ID#	2. Data Development Cost ($)	3. Consultant Development Effort Cost ($)	4. Hardware and Software Cost ($)	5. Consultant Time for Implementation	6. Consultant Time for Data Development	7. Consultant Time for Support Documentation	8. Consultant Time for Users Guide
1	187,500	195,000	10,000	1,000	2,500	150	150
2	30,000	93,000	10,000	500	400	60	60
3	7,500	72,000	15,000	400	100	40	40
4		45,000	5,000	200	0	50	50
5		90,000	10,000	500	0	50	50
6	7,500	72,000	30,000 District PCs	400	100	40	40
7	375,000	90,000	15,000	400	5,000 Collect 5 yrs of accidents	50	50
8		105,000	0	600	0	50	50
9	7,500	54,000	0	320	100	40	0
10		171,000	0	1,000	0	60	80
11		87,000	0	500	0	40	40
12		87,000	30,000 Laptops at districts	500	0	40	40
13	24,000	39,000	10,000	200	320	30	30

1. ID#	2. Data Development Cost ($)	3. Consultant Development Effort Cost ($)	4. Hardware and Software Cost ($)	5. Consultant Time for Implementation	6. Consultant Time for Data Development	7. Consultant Time for Support Documentation	8. Consultant Time for Users Guide
14	15,000		0	0	200	0	0
15	75,000	69,000	0	400	1,000	30	30
16	7,500	15,000	0	0	100	0	0
17	225,000	648,000	100,000	4,000	3,000	160	160
18	7,500	54,000	0	320	100	40	0
19		72,000	30,000	400	0	40	40
20		39,000	0	200	0	40	20
21	22,500	127,500	15,000	750	300	60	40
22	22,500	111,000	0	640	300	60	40
23	60,000	93,000	10,000	500	800	60	60
24	7,500	60,000	0	320	100	40	40
25		435,000	200,000	2,500	0	300	100
26		99,000	0	560	0	60	40
27	75,000	348,000	0	2,000	1,000	200	120
28	75,000	180,000	10,000	1,000	1,000	100	100
29	150,000	180,000	10,000	2,000	2,000	100	100

Feasibility Measure Scoring Table

Table 5 was used to score and rank each application. A scale of 1 to 5 is used for each category. A “1” is the negative or low number, indicating a ‘bad’ score for the category. A “5” is the positive or highest number, indicating the ‘best’ score for the category. Each column’s score was considered equally; no weights were applied to specific categories. A total score was calculated for each application, and the applications were ranked according to this score, where a higher score indicates a higher rank. The following are descriptions of each measure (column in the table), and how the individual measure score was applied.

1. ID number of the application.
2. Data Availability. Score from 1 to 5, where “1” indicates no data is available, and “5” indicates all data is available.
3. Level of Development Effort. Score from 1 to 5, where “1” indicates extensive effort is required and “5” indicates little effort is required.
4. Clearly Defined End Product. Score from 1 to 5, where “1” indicates a poorly defined product and “5” indicates a clearly defined product.
5. Maintenance. Score from 1 to 5, where “1” indicates extensive maintenance effort is required and “5” indicates little maintenance is required.
6. Complexity of Use. Score from 1 to 5, where “1” indicates difficult or complex use and “5” indicates easy use.
7. Frequency of Use. Score from 1 to 5, where “1” is used for yearly use, a “3” for monthly use, and a “5” for daily or weekly use. Other or sporadic use is scored based on the importance of the application when it is used. *(as indicated on the template)*
8. Current Use. Score from 1 to 5, where “1” indicates the application is not currently being performed, and a “5” indicates the application is being performed currently without the assistance of GIS.
9. Importance. Score from 1 to 5, where “1” is used for low importance, a “3” is used for medium importance, and a “5” indicates high importance. *(as indicated on the template)*
10. Transportation Program. Score from 1 to 5, where “1” indicates the application does not relate to the CTP and “5” indicates the application is very important or highly related to the Program.
11. Total. A calculated total of all columns for each application.
12. Rank. Rank of applications from 1 to 27 based on total score.

Table 5 – Feasibility Measure Scoring

ID#	Data Avail.	Develop Effort	Clearly Defined End Product	Maint. of Data or Applic.	Complexity of Use	Frequency of Use	Current Use	Importance	Transportation Program	Total	**Rank**
1	2	2	3	2	3	5	3	5	2	27	24
2	4	3	3	2	3	5	4	5	4	33	14
3	4	4	4	5	2	5	2	5	4	35	10
4	5	4	5	4	5	4	5	5	5	42	1
5	5	3	5	4	4	5	5	5	4	40	2
6	5	4	4	4	4	3	4	3	3	34	11
7	3	3	5	4	4	3	1	3	4	30	20
8	5	3	3	4	3	4	5	5	4	36	5
9	4	4	2	4	4	5	3	5	5	36	5
10	5	2	4	3	3	5	4	5	5	36	5
11	5	4	4	4	4	4	3	5	4	37	4
12	5	3	4	3	4	4	3	3	2	31	17
13	1	4	5	3	5	3	1	2	1	25	27
14	3	5	3	3	5	5	1	5	2	32	15
15	2	4	4	3	4	3	1	3	2	26	26
16	3	5	3	3	5	5	1	5	2	32	15
17	1	1	4	2	3	5	2	5	1	24	29
18	5	4	5	4	5	3	3	3	2	34	11
19	5	3	5	3	4	5	3	3	3	34	11
20	4	5	5	3	5	5	3	5	4	39	3
21	4	3	5	4	4	5	2	5	4	36	5
22	2	3	4	4	3	5	2	5	3	31	17
23	3	3	4	2	3	3	1	5	1	25	27
24	4	4	5	4	4	3	1	3	1	29	22

ID#	Data Avail.	Develop Effort	Clearly Defined End Product	Maint. of Data or Applic.	Complexity of Use	Frequency of Use	Current Use	Importance	Transportation Program	Total	**Rank**
25	4	2	3	2	3	5	3	5	4	31	17
26	2	3	5	2	4	5	3	3	1	28	23
27	2	2	4	2	4	5	5	3	3	30	20
28	2	3	5	3	4	5	5	5	4	36	5
29	2	2	5	1	4	3	2	5	3	27	24

Application Implementation

Staffing

The Cartography Unit in the Bureau of Transportation Planning has three staff people for development of GIS applications, and the Bureau of Computer Services supplies two staff for support and project management of GIS activities. The following sections detail a recommended order of implementation for the applications that assumes the current staffing level (three project management teams) will be maintained. The current staffing level allows for the concurrent development of three applications (one application per team), while still providing miscellaneous GIS support for the Department. The ongoing efforts involved in developing the TRIS application require the attention of one project team, allowing the development of two new projects. The general GIS activity will provide support for existing and new applications, perform requested mapping and data tasks, and generate presentation materials. This support may also take the form of a GIS Help Desk.

A second schedule is presented that is based on a more aggressive implementation of applications, at a correspondingly higher cost per year. This aggressive approach assumes the concurrent development of four applications (including TRIS), while still providing miscellaneous GIS support. The aggressive approach requires that project team members will have to work on more than one project at a time.

The Bureau of Computer Services would continue to supply project management and support services for application implementation.

Several applications have a need for additional FTEs. These positions are needed for maintenance of the specific application following implementation, and would primarily be involved in data collection and updating activities. These positions would generally be in the unit or section that is using or housing the application. These FTEs are not involved in the implementation work, but availability of this staff for application maintenance activities is certainly a factor in the actual scheduled start of an application.

Recommended Order

The applications are presented here in their recommended order of implementation, as determined by the GIS Subcommittee. This order generally was determined from the Feasibility Scoring table rank (**Table 5**). Where several applications received the same ranking, a subjective measure was used to ‘break the tie’. This measure, as well as an evaluation of each application’s rank, is described for each application.

The first five applications are those recommended for implementation during fiscal years 2001–2003, given current development and support staffing resources at KDOT.

(ID#4) The Bureau of Program Management Decision Maps rank as the top priority application. This application rose to the top because of its relatively low application time and cost estimates and its importance to both current KDOT missions and the new Transportation Program. This application will not have any new data collection costs, and should be relatively easy to implement.

(ID#5) The Bureau of Transportation Planning wants to be able to find, select, and display high accident locations. This application is highly ranked because it should be relatively easy to develop, has no data collection costs, will be used frequently, and is clearly defined. Application efforts will include developing an interface to KARS and CANSYS II for access to data. This application is important to the Comprehensive Transportation Program and will be used by other groups within the Department.

(ID#20) Construction and Maintenance would like to have a Web application that will allow both the entry and display of construction and detour information. Similar efforts have already been implemented by KDOT, which should ease development efforts. This application will also be highly visible, as many groups within KDOT will use it, and the transport industry as well as the traveling public will access it.

(ID#11) This application will allow the creation of NOS maps throughout KDOT. These maps are currently created and distributed in hardcopy form, particularly to the districts. The application will automate the process and allow more timely access to the data by the district staff. This application has no data collection or system costs.

Five applications have a ranking score of "5". These five applications have a wide variety of constituents and uses, and unfortunately cannot all be scheduled into this implementation schedule given staffing constraints. They are all included in the more aggressive schedule described below. Application #28, GIS basemap recompilation and addition, has already been selected for implementation because of the groundwork it provides for other applications, and the importance it has for statewide GIS initiatives and cooperation with other GIS efforts.

(ID#28) The Cartography Unit will re-compile and enhance the GIS basemap using the 1:12,000 digital orthophoto quarter-quad maps now available. This will make the basemap consistent with other GIS efforts throughout the state, and improve the integration of GPS data with the basemap. This application will include the addition of the 34,176 miles of FHWA Functional Classification roads through minor collector (non-state system).

The next five applications should be developed during fiscal years 2001-2003, if the more aggressive implementation of GIS applications is followed.

(ID#21) This application will allow MMS information to be displayed with GIS, and distribute this information throughout the Department, including the districts. This represents a full-year effort for FY 2003 under current staffing levels. This is a clearly defined application, important to the Transportation Program, and should be frequently and widely used. This application is second among the programs of rank "5" because it would serve a wider group and a group that will not have benefited by GIS to this point.

(ID#9) The Bureau of Local Projects, Bridge Inspection Unit, wants to tie bridge inventory data to GIS. This application was not clearly defined, which dropped it in rank. The intent of the application is to integrate the NBI program underway with GIS. NBI information is generally GIS-ready, and this should be a relatively easy application to develop.

(ID#10) This application is the fourth of the five with a rank of “5”. This is a very important application to KDOT and the Transportation Program, but it is also a very ambitious one. It was felt that the over-arching PMIS should be developed in a phased approach, particularly due to its reliance on historical data. The issue of handling historical data with the current GIS basemap and LRS must be addressed for this to be a successful program. The development of the NOS application will build some of the foundation for this system.

(ID#8) The Statewide Planning Unit has a need for TransCAD integration in addition to accommodating traffic models within GIS. This application does not have any data collection or hardware/software costs, which improves its rank. The ability to translate the GIS basemap to TransCAD in a timely manner while retaining its intelligence will help towards meeting the goals of this application.

(ID#3) The Environmental Services Section (ESS) would like to view some of the design information for environmental review, and perhaps use contour data for some specialized terrain modeling. The ESS will require the additional ARC/INFO and/or ArcView extensions to actually perform the type of analyses they want, and much of what they want to do will remain a complex process not easily handled by an application. The ability to get the DGN files into ESRI products can be done, which is what raised this application to its rank.

The remaining applications do not fall in the aggressive schedule. They are presented here in order of rank.

(ID#18) Traffic and Field Operations would like to be able to post and view traffic count information through the Internet. This should be an easy application to produce, without data collection costs. The scores for importance and use taken from the received template knocked this application down in rank.

(ID#6) The Bureau of Local Projects’ need for a maintenance agreement viewer application should be an easy Internet application to develop. It has some hardware costs for PCs at the districts, to be used for entering and viewing data, but not a lot of development or data collection time. The scores for use and importance reduced the rank of this application.

(ID# 19) Traffic and Field Operations expressed a need for a traffic count data collection tool. This is a clearly defined application with no data costs. The scores for importance and after-development maintenance costs reduced this rank, as this is a very specific application for a group.

(ID# 2) The Environmental Services Group would like to track projects and perform reviews in a more timely manner. Their application will require access to the CANSYS II and CPMS databases, as well as the GIS basemap, and do much of the analysis in ESRI GIS products. This application will be somewhat difficult to define and develop, will have some data maintenance issues, and will remain fairly complex. These are the scores that have dropped this down in rank.

(ID#14, ID#16) These two ITS applications are very similar in scope. The analysis focused on providing GIS information to the ITS efforts proposed for both Metropolitan Areas, rather than on the ITS efforts themselves. These are data-driven tasks, without program development. Data sharing or translation efforts need to be better defined, as does the amount and type of information actually needed. These two tasks may in fact be able to be performed early in the schedule if the effort is strictly a well-defined data sharing arrangement. In fact, these two applications have been completed during the course of this study.

(ID#12) The POS should build on the efforts of the NOS and PMIS programs as part of a phased approach to a full PMIS. This is ranked as a less important application, particularly to the Transportation Program.

(ID#22) The Construction and Maintenance Unit's QA application should build on the MMS application developed earlier in the cycle. This application, like POS, is less important within the user group and is more difficult to develop.

(ID#25) The ability to access legacy data with a GIS interface received a high importance score, and this application would be especially useful to district offices. This may be a very expensive and time-consuming application to build, which lowered its score. The application did not define any specific queries or uses of the legacy data or applications of the data. It will also require after-implementation database maintenance support. However, this application can be achieved in phases over several years, if the application is treated as a series of database efforts instead of a conversion of all information at once. Further refinement of this application may result in a prioritized list of legacy data to provide access to, and the work can proceed in steps based on this prioritized list.

(ID#27) Much like ID#25 above, the ability to get the strip maps into a GIS-ready form for wider and more timely distribution through the Department will have many benefits and be used frequently. However, this will be an extensive development effort, with after-development maintenance costs.

(ID#7) The collection of accident data for the Bureau of Local Projects to use to help local agencies is quite extensive. The application itself is very similar to that of ID#5, which received a very high rank, but the data costs for this project move it down the list. This application will depend on the local road layer of the proposed new GIS basemap.

(ID#24) A maintenance activity reporting database application would be very helpful for management purposes, but this application received low scores for current and planned use, and its importance to the Transportation Program was also rated low.

(ID#26) The Cartography Unit would like to change the process for updating the county map series. This application received low scores for importance to the Transportation Program and for maintenance of data and the application following implementation.

(ID#29) The Cartography Unit would develop a local road layer for the GIS basemap. This application is important to other GIS initiatives in the state, which would like to use a standard and accurate base layer of roads, including local roads. The digitizing of the local roads, and establishment of a location referencing method for those roads will be extensive.

(ID#1) The Bureau of Traffic Engineering's driveway/access permit application has high data development costs. The current location of driveways and other access points must be collected, which will be a substantial effort. The development of the application also received high estimates for level of effort.

(ID#15) The development of a telecommunications infrastructure database received low scores for use and importance, and has a fairly high data development cost. An application to query and map the data would not be difficult.

(ID#13) As in ID#15 above, a cellular coverage database has high data costs initially, is not currently being performed by KDOT, and has low significance to the Transportation Program.

(ID#23) A snowplow routing application may have significant data development activities, depending on the complexity of the routing algorithms that may be used; it may require much enhancement of the GIS basemap.

(ID#17) A sign inventory management system is perhaps the most ambitious application proposed, and it received low marks for data availability and maintenance, development effort, and importance to the Transportation Program. A phased approach to an inventory system may be warranted and worth an additional look.

Schedule

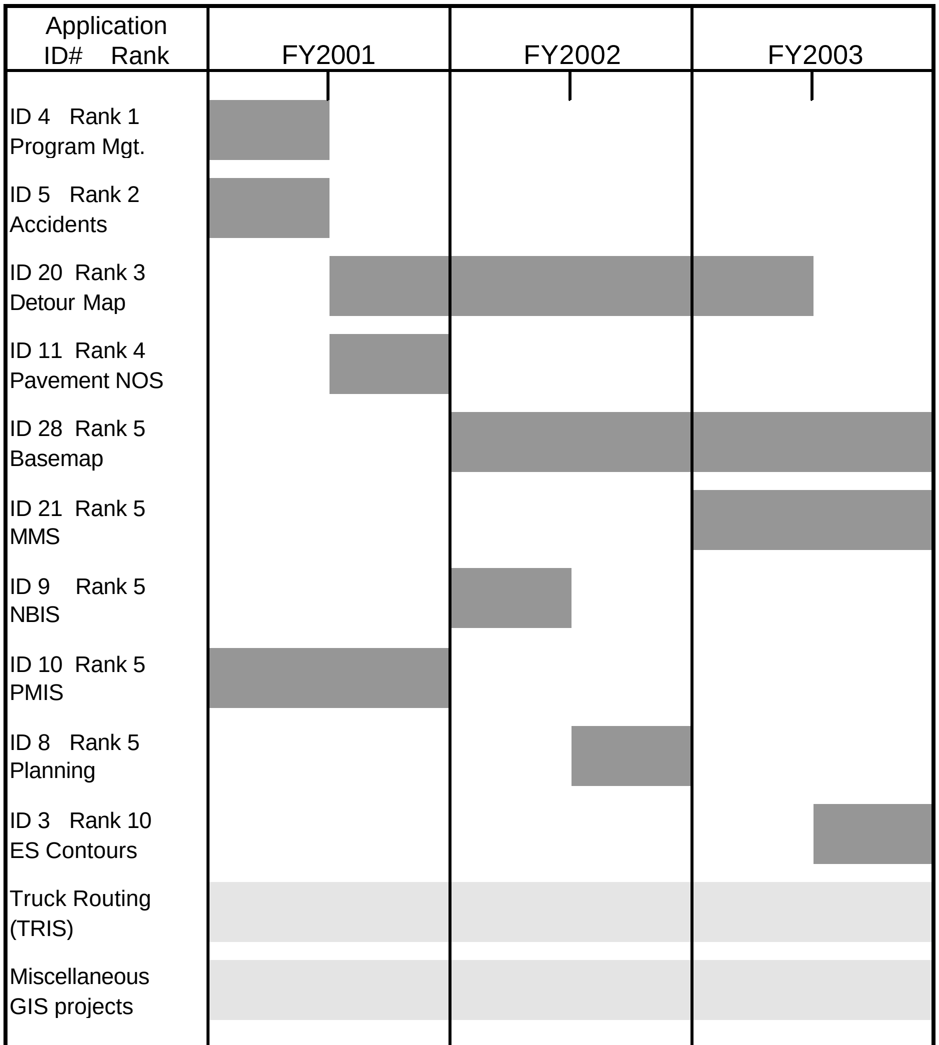
Table 6 shows the implementation schedule and costs for fiscal years 2001-2003. This schedule assumes that, given the current staffing levels, three applications (including TRIS, shown in a lighter shading) can be developed at a time, and only three applications can be achieved during any six-month period. The table also shows the ongoing efforts involved in miscellaneous GIS support services, though these services do not require a dedicated project team. The cost figures provided at the bottom of the schedule are for new applications only. Where an application is developed over two or more fiscal years, the costs have been apportioned out to each fiscal year.

Table 6 – Implementation Schedule and Costs FY 2001-2003

Application ID# Rank	FY2001		FY2002		FY2003	
ID 4 Rank 1 Program Mgt.	■					
ID 5 Rank 2 Accidents		■				
ID 20 Rank 3 Detour Map		■	■	■	■	
ID 11 Rank 4 Pavement NOS						■
ID 28 Rank 5 Basemap			■	■	■	■
Truck Routing (TRIS)	░	░	░	░	░	░
Miscellaneous GIS projects	░	░	░	░	░	░
Costs						
HW/SW	$ 15,000		$ 10,000		$ -	
Data	$ -		$ 50,000		$ 25,000	
Development	$145,000		$110,000		$187,000	
Year Total	$160,000		$170,000		$212,000	

Table 7 shows a more aggressive implementation schedule and costs for fiscal years 2001-2003. This schedule assumes that more than three projects can be tackled during any six-month period and results in more applications being rolled-out during the time period. This table again shows TRIS as an ongoing project, requiring the attention of a project team. The table also shows the ongoing efforts involved in miscellaneous GIS support services, though these services do not require a dedicated project team. The cost figures provided at the bottom of the schedule are for new applications only. Where an application is developed over two or more fiscal years, the costs have been apportioned out to each fiscal year. A miscellaneous cost is also shown, illustrating the costs of miscellaneous GIS activities and the TRIS project.

Table 7 – Aggressive Implementation Schedule and Costs FY 2001-2003



Costs	FY2001	FY2002	FY2003
HW/SW	$ 15,000	$ 10,000	$ 30,000
Data	$ -	$ 40,000	$ 65,000
Development	$ 403,000	$ 276,500	$ 299,500
Miscellaneous	$ 123,000	$ 176,000	$ 106,000
Total	**$ 541,000**	**$ 502,500**	**$ 500,500**

KDOT's GIS in the 21st Century

This GIS Strategic Plan for the Kansas Department of Transportation is designed to provide a blueprint for expanded development of GIS over the next few years. Proposed projects listed in the previous section have been targeted for development for Fiscal Years 2001-2003. No actions were specified beyond this time frame because of the rapidly changing environment for GIS at KDOT. The implementation of the CTP will affect GIS operations substantially and help to shape its nature. Additionally, the success of KDOT in adding in-house GIS staff and to contract work will define how much can be accomplished as well as the associated time schedules.

As a result of these future uncertainties, it is recommended that the GIS Strategic Plan be reviewed at least annually, adjusted as necessary, and changes documented in a brief document report. This could be accomplished along with preparation of an annual status report. It is also recommended that a more formalized revisiting of the GIS Strategic Plan process be conducted and documentation compiled during Fiscal Year 2003. This could assume the form of another complete GIS Strategic Plan process that results in a report comparable to this document, or through a modified review process. The GIS field is changing quickly both in terms of technological advances and in the organizational resources required to manage a program. KDOT will best ensure a successful GIS by keeping up with changes required to support its essential business functions.

There are also more specific issues that will influence the nature of KDOT's GIS between now and 2003. For the purposes of this section, these can be divided into technological and organizational issues, although many contain both aspects.

Technological issues include:

- **Advances in client-server technology** primarily will provide increasingly attractive World Wide Web-based GIS solutions for Intranet and Internet implementation. This is potentially a major cost saver for KDOT and an attractive solution for extending GIS functionality to district offices.
- **Advances in data storage technology** will assist KDOT in management of large amounts of map graphics, attributes, and imagery more efficiently. Digital orthophotography, for example, will become more widely available and accessible to GIS through image compression technology.
- **Use of GPS and field computers** will continue to grow, with many governmental agencies (such as the Kansas Highway Patrol) likely to use the technology for field data collection. GPS improvement of basemapping is an issue that must be considered by KDOT.

Organizational issues include:

- **How GIS will be placed in the KDOT organization** still needs to be formalized. Staffing for GIS must be successfully addressed to ensure the validity of the program.
- **The role of GIS as an Agency-wide data integrator** must be considered. GIS is capable of serving as a central "core" for data management at KDOT in many respects. Linkages to

existing legacy databases will help to promote this idea, but more definition is needed as to how GIS fits into general data management plans for the Agency.

- **Further definition of GIS customers** is needed, and is changing rapidly. A move away from consideration of the Central Office as the only "customer" should occur. District offices, other government agencies, DASC, and the general public will increasingly become customers for KDOT's data, with GIS as a primary method for exchange. How KDOT addresses these demands will shape its future function and structure.

KDOT has done much to support successful development of GIS already. Current projects are involving incorporation of GIS into important business functions, and continued development of "early winner" GIS projects is important to long-term success. The strategic planning process as summarized in this document will facilitate the further integration and use of an enterprise-wide GIS at KDOT. The next few years should see GIS become a well-accepted, valuable part of KDOT's daily operations.

Glossary and Acronyms

AADT – Average Annual Daily Traffic

ATIS – Advanced Traveler Information Systems

ATRS – Automated Traffic Recorder System

CADD – Computer-Assisted Design and Drafting

CANSYS II – Control Section Analysis System (version II is the original database CANSYS converted from flat files (Basic Direct Access Method) into Oracle)

CPMS - Comprehensive Program Management System

CTP – Comprehensive Transportation Program

CDRS – Construction and Detour Reporting System

CVRG – Coverage counts/traffic systems database

DASC – Data Access and Support Center. Maintained through the State of Kansas Geographic Information Systems Policy Board.

FHWA – Federal Highway Administration

FTE – Full-time Equivalent

FY – Fiscal Year

GIS – Geographic Information System

GIS-T – GIS for Transportation

GPS – Global Positioning System

ITS – Intelligent Transportation System

KARS – Kansas Accident Records System

LRM – Location Reference Method

LRS – Linear Referencing System

MMS – Maintenance Management System

NBI- – National Bridge Inventory

NOS – Network Optimization System

POS – Project Optimization System

PMIS – Pavement Management Information System

RCRS – Road Condition Reporting System

RDBMS – Relational Database Management System

TOC – Traffic Operations Center

TRIS – Truck Routing Information System

Index

Reference Materials

- KDOT 1995 GIS Directions Report
- KDOT 1995 LRS Study Report
- KDOT 1996 ITA Plan
- Kansas 1997 GIS Strategic Plan (Kansas GIS Initiative)
- KDOT 1998-99 ITA Plan
- KDOT 1998-99 Strategic Telecommunications Plan
- KDOT 1998-99 ITS Plan
- KDOT 1996 Strategic Management Plan

Appendices

Appendix A – Interviews Summary

Work Function:

1. Define the mission and goals of your particular work function.

The interviewees provided a wide variety of responses, but all were able to describe their primary work function sufficiently for the interviewers to understand, and this was the primary purpose of the question. The responses ranged from the very broad ('service and support to the Agency') to the very specific ('Section 402 work with local agencies'). The interviewees were able to describe the processes they used in their work, information that they used, and the products they generate.

2. Describe who the "stakeholders" are for your products (i.e., other units, general public, other state offices, etc.)

Again, the interviewees provided a wide variety of answers, reflecting the different units and the work they do. Answers ranged from the very broad ('the traveling public') to the very detailed ('Bureau of Design, Bureau of Planning'). It is clear that the constituents for the work of the staff include the public, other state agencies, various units within KDOT, consultants, contractors, law enforcement, motor carriers, and a few others.

3. What data and maps do you use? What data do you use/need on a daily basis?

One important fact that emerged from the responses showed that most individuals use some sort of data or map. Currently, it appears that KDOT relies on project data, roadway data and bridge data, and city, county and state maps to perform their work functions. The following lists the data and maps mentioned by interviewees.

- Project data and maps
- Accident data
- Maintenance activities data
- Bridge data and maps
- Hydrology maps
- City, county and state maps
- Property maps
- Pavement markings
- TIGER/Census data
- Sign inventory data
- KDOT basemap
- Traffic volume data
- USGS quads
- Video logs
- Historical site data
- Salvage yards data

4. What kinds of data or maps are not available to you that would be helpful in performing your business functions?

In most cases data is available within KDOT, but every individual does not have access to current data. Data and maps not available in KDOT must be identified, so that KDOT can integrate data and maps throughout the Agency. Also, some respondents would like available on-screen GIS maps. The following lists data elements mentioned by respondents as needed and not available to them.

- Accident data
- Roadway and bridge data tied to maps
- More project information maps
- Integrating accidents and roadway data
- Congestion information
- Highway corridor data
- Traffic volume
- Maintenance management maps
- Pavement marking
- Signage and lighting data
- Tax maps
- USGS maps
- Utility locations
- Property ownership maps

5. The person or Agency that updates and/or owns the information needed.

It is clear from the responses that the information comes from a wide variety of sources, and also varies by work function. Some groups get information from Kansas University and Kansas State University, from DASC, and from other federal and state agencies. Other data comes from within KDOT, with 'Various Bureaus and Sections' and the Division of Design and Engineering mentioned most often. Other groups mentioned that they generate and own their own data.

6. How could data sharing be improved in the Department? (Internal and External data sharing)

The most important answers asserted that data must be made available, and that potential users must be able to find and access it. Many of the responses indicated that data must be made available, and importantly, accessible through the KDOT network(s). Staff felt that data was not available to them for use, either because the needed data was not available across the network, that it was in a format that could not be used, or that there were restrictions on use. The second most important theme was the lack of information about data – what data the Department has, where it is (on the network), who is responsible for it, and what format it is in.

The pending Record and Workflow Management project was mentioned by several users as possibly making data more available, or easier to access. Staff also mentioned that data should be referenced to the LRS, to make it easier to use.

7. How could your data analysis process be improved?

The answers to this question followed along the theme of the previous question. Many respondents felt that data analysis would improve if access to data were improved. Staff mentioned 'getting data in a timely manner' or 'having current data on-line'. Other responses mentioned access to data, tools for data analysis, and links between data types, such as between CPMS and CANSYS, or between data and CADD or travel models. Several mentions were made of possible applications, with people having good ideas of how they wanted data connected if they could do it.

8. What types of output documents need to have maps or graphics included?

One important fact emerged from the responses showed that everyone had a need to enhance their documents with graphics. Respondents stated that graphics would help improve decision-making within KDOT. The overwhelming need cited was for construction project information. The second priority group includes mapping for roadway, bridges, traffic, accidents, and maintenance activities. Respondents identified various documents that would be enhanced by graphics.

- Project/Construction information
- Bridge data
- Roadway data
- Annual program
- Signing projects
- Guardrail data
- Highway maintenance activities
- Right-of-way plans
- Travel information
- Web data
- Traffic forecast
- Routing
- Accident locations
- Snow and ice performance

Technology:

1. **What new capabilities, or "tools," would you like to have? (e.g. GIS, Graphic User Interfaces (GUI), Intranet, Internet).**

   The predominant answer was that staff would like to have a GUI or a combination GUI/GIS tool for access to data. Essentially staff would like an easy-to-use tool on every PC that would either perform specific applications or that would allow the staff to more easily access information. Several interviewees specifically mentioned a GUI/GIS that would allow them to easily query data and view it on a map or produce maps.

2. **Describe how familiar you are with computers/PC in general. (1=none through 5=very)**

   Nearly all respondents gave themselves and the Department high grades (one "3" was the lowest number). Support of computers seems to be a problem, though. Several respondents indicated that they spend a lot of time providing support for themselves and colleagues in their unit.

3. **How would you define GIS?**

   Far and away the most popular responses included the words, maps, or graphics and data or information in the same thought. Several of the responses see GIS as a way to retrieve, display and/or analyze transportation information for day to day business functions. As per NCHRP, a simple GIS definition is "specialized software for the management and analysis of spatial data and their attributes."

4. **Why is GIS Important? How can GIS help you do a better job?**

   One important fact that emerged from the responses showed that most individuals were aware of the potential of GIS for data access and integration across the entire organization. Currently, it appears that it is not easy to access the transportation data and it is believed that GIS could provide KDOT staff with "information at their finger tips."

   With respect to helping them do a better job, it is felt that GIS could enable them to do their work faster and better since information will be in an easy-to-use graphic format. Respondents stated that GIS would improve the quality of data, operations and decision-making at the Department.

5. **What functions of your job currently require the use of GIS? What functions of your job would you like to use GIS?**

   A lot of respondents were interested in GIS and wanted to incorporate GIS into their workflow. Most respondents do not currently require GIS, but thought it would make their daily task more efficient. Some respondents did not need GIS until we discussed their functions within KDOT. Many respondents were surprised and excited about GIS and what it could do for KDOT. The respondents identified many functions within KDOT that could use GIS.

   - Interfacing and viewing KDOT data
   - Providing decision support maps for construction and maintenance projects

- Accessing guard rail database
- Furnishing construction and detour maps
- Communicating past, present and future transportation initiatives
- Interfacing pavement, lighting and speed zones systems
- Routing over weight/size trucks
- Providing districts with utility data and striping data in GIS format
- Viewing maintenance activities on maps
- Overlaying accident data with roadway features
- Improving quality assurance process
- Linking road conditions to GIS
- Analyzing performance of signs

6. How do you see GIS capabilities fitting into the KDOT work process?

The most prominent themes in this answer are the potential of GIS to provide access to information by tying data together, and providing decision support. Nearly all interviewees were enthusiastic about the potential of GIS to help processes, and most felt that it would be a regularly used and valuable tool. Many see GIS as a data integration tool that would allow disparate data sources to be used together, providing analysis of information.

7. How do you see GIS capabilities being utilized by yourself? Is there a need for an "executive information system" that can display spatial data (i.e., maps) for KDOT?

If the Executive Information System (EIS) or GIS/GUI for users will truly be easy to use, it would be well received. The key item staff mentioned was 'ease of use'; the EIS must be easy to be used at all. Many staff also felt the EIS needed to have a graphic component, particularly the ability to produce maps.

Staff that felt an EIS was not needed, however, did mention that they wanted a system that provided access to data with either built-in queries or ability to perform queries on data.

8. What do you believe are KDOT's current strengths with GIS Technology?

There were different strengths identified for GIS technology within KDOT. Many individuals stated that KDOT had knowledgeable and dedicated staff that works well together. According to many respondents, KDOT's strengths lie in its common basemap and wealth of transportation data.

9. What do you believe are KDOT's current weakness with GIS Technology?

The popular response always seemed to say the same message - GIS is highly complex, and more time needs to be spent on training and support. It appeared that most respondents think GIS efforts need to be focused by utilizing resources within KDOT to be more efficient.

10. What are some of the opportunities for GIS at the Department?

Many respondents provided some excellent opportunities for GIS. It is clear that many respondents believe that KDOT has opportunities for decision support mapping, data integration, education, and GPS. It is believed that KDOT does not showcase GIS capabilities enough. The following summarizes the comments:

- Unlimited number of maps based on queries (spatial analysis)
- Integration of databases with GIS
- Planning of resources
- Develop specific applications
- Interactive mapping
- Ability to showcase the state of Kansas
- GPS/LRS integration
- Keeping data clean and accurate (data integrity)

11. What are some of the challenges for GIS at the Department?

By far, most respondents stated that the challenges would be GPS/LRS integration, data conversions from legacy to relational systems, keeping data integrity, and staffing issues. The following summarizes the comments:

- Data collection, accessibility, ownership, maintenance, and integrity
- Staffing issues
- GPS/LRS integration
- Accessibility and ownership of data
- Education/training/acceptance

12. What impediments do you foresee for further GIS implementation and distribution?

Everyone that was interviewed had at least one impediment that could hinder the implementation of GIS. It is important to identify these impediments up front and work hard to prevent them. The following summarizes the comments:

- Resistance of staff to technology and change
- Refusal to share data and turf battles
- Not providing a supporting organizational structure
- Competing priorities and lack of focus
- Insufficiency funding

- Lack of understanding of the transportation data and business

13. What would be your priorities for new GIS applications?

Respondents mentioned many types of applications, from very specific tasks for their unit or section to general products such as putting data on maps. Many of the ideas were based on having access with GIS to KDOT's data in systems such as CANSYS, CPMS, and KARS. The staff's applications ideas were summarized into the following list. General categories describing similar types of applications are presented. The list is generally ordered by the frequency of application ideas – the first category was mentioned most often, second category next most often, etc.

Construction Projects – Supporting everyday work with the Transportation Program 2000, and putting the program in a user-friendly environment. Identify where construction projects are located, provide GIS links to project information (cost, design, letting, completion, etc), and construction lane closures and detours. The system would provide maps for communicating the program initiatives to the legislature, other state and federal agencies and the general public.

Road Conditions – Respondents described applications that would let KDOT staff see the location of construction, detours, posted bridges, snow/ice conditions, and other factors affecting travel, and be able to query information about the conditions. Staff also mentioned allowing the public, including motor carriers, to view this information through the Internet to serve as a Traveler Information System.

Routing and Permitting – Staff described various ideas that would improve the issuance of permits and develop travel routes for vehicles requiring permits, such as overweight/oversize trucks and Hazmat. These applications would require information about bridge clearances and posted weights, congestion, and other road/bridge data.

Roadway Information System – Separate from Road Conditions, this system would provide information about KDOT assets along the roads, as well as other elements that KDOT tracks, such as traffic. The system would provide a GUI, maps, and allow query of information about such features as guard fences, pavement markings, signs, lighting, billboards, etc.

Accident Data – Several respondents advocated the ability to view accident locations and information about the accidents, and to work with law enforcement agencies on reporting methods for accidents, such as using GPS locations. The districts could use accident information and maps in the planning of highway projects and maintenance activities.

Maintenance Tool – Ideas were generated about providing a tool for maintenance activities, particularly in the district offices, that would allow the planning, tracking and display of maintenance activities.

Data – Several staff mentioned the ability to acquire and use other types of data, including the CADD design drawings, old design plans, digital orthophotos, video logs, and right-of-way information.

Miscellaneous – Other ideas mentioned included using GIS for travel demand forecasting and/or integrating GIS with traffic models, increasing the ability of Environmental Services to do proactive project planning and producing 'decision support maps' without having to know how to produce a map.

14. What problems are you having in using GIS that are related to hardware/ software/networks/operating systems?

Many, mostly minor problems, were related by the interviewees, which are summarized below. Support problems were mentioned again, as were disk storage limits for some people. However, there is no problem or limit that seems to be pervasive throughout the organization.

- Network speed and capacity are limits – need progress toward 100Mbps
- Internet connections seem to be dropped randomly
- Software version control – different versions of same software
- Integrating different software platforms – ARC/INFO, TransCAD, Intergraph

15. How would you rate your Linear Referencing System (LRS)? (1=none through 5=very good) How could KDOT's LRS be improved?

The answers to questions regarding the LRS varied widely. Some staff thought the LRS standard of KDOT was well done and they use it, others felt that the LRS was not useful or encompassing enough and other staff did not use the LRS. Of the staff that did not use LRS, they either referenced their data by some other system (such as serial number or GPS) or did not have GIS or other software that used LRS.

Many staff felt that the LRS was not adequate for all situations. For instance, some staff had need to reference information on local roads, which are not covered by the LRS. Still others work with data referenced by milepost, which is used by law enforcement. Other staff felt that more databases need to have LRS keys, and that the Agency standard for LRS should be enforced.

There is concern that the LRS will not be able to accommodate changes in data collection. Many staff expressed concern that GPS data must be used in conjunction with LRS, and others felt that GPS should replace the LRS.

16. Do you use or plan to use GPS to meet your business functions? How?

Current use of GPS is by the surveyors for design projects; they are collecting centerline and section corners, as well as control points. Some law enforcement agencies, including KHP, use GPS to some extent but do not provide information to KDOT yet.

Planned use of GPS is fairly extensive. Staff has many ideas for using GPS to collect locations of features such as signs and bridges, and to make use of the GPS data in the future.

Some staff expressed a need for integration of GPS data with other efforts, in particular with LRS.

17. How do you envision GPS data being incorporated into the GIS environment?

There were many ideas for use of GPS. Many staff envision GPS as another means of collecting location information, and look for GPS to be used extensively by field crews.

Staff also expressed a need for integration of GPS with other efforts. In particular, GPS must be linked with GIS and LRS, and the basemap should accommodate GPS accuracy.

18. What needs to be accomplished in order to have GIS succeed in KDOT?

It is believed that there are some steps that can be taken which could provide a successful GIS in Kansas Department of Transportation.

- Furnish a strong foundation (organization and technology)
- Secure top management buy-in
- Develop an affordable plan and priorities
- Keep GIS implementation simple
- Provide communication, training and exposure of GIS to staff
- Create early products and successes

19. What avenues are open to funding GIS operations?

In most cases, funding does not appear to be a major concern because KDOT already has mechanisms in-place to fund IT projects. However, the use of federal funds could provide a higher priority and accelerate the budget and funding of GIS.

20. What types of database programs are used? For what purpose?

Interviewees mentioned many of the KDOT large computer systems, including CANSYS, KARS, and CPMS. Several also mentioned other programs and databases that their group works on and frequently stores locally. Staff use Microsoft Access and Excel for databases, as well as PC-File+. Many users collect subsets of data out of CPMS or CANSYS and copy it into their own databases, and use that information for their particular task. Some, in fact, re-enter data into databases from hardcopy reports from CPMS.

Many of these user databases are stored on local systems and are not accessible across the network(s).

Organization:

1. **What needs exist for interdepartmental coordination of GIS efforts? What has worked so far? What has not worked?**

   Responses were varied; most looked for coordination and communication, as well as some direction and standards. The responses are summarized:

   - Coordination between departments
   - Finding and establishing the right people for GIS work
   - Defining and working with standards, particularly LRS and hardware/software
   - Open discussions and communication of GIS news in the Department

   Some interviewees felt that current coordination efforts have worked so far, but the level of effort must be stepped up as GIS use grows.

2. **How do you feel about outsourcing GIS work?**

   Opinions were somewhat divided on the use of consultants or contractors to perform at least some work. Some respondents were opposed to any outsource work, preferring to keep the work and expertise in-house. Most respondents felt that outsourcing was either necessary due to lack of expertise within KDOT, or because of lack of staff availability for the workload. Nearly all interviewees agreeing with outsourcing felt that there needed to be KDOT management of the process, and a flow of the expertise used from the consultant/contractor to KDOT staff.

3. **Where do you see GIS functioning in the organization structure of KDOT?**

   Responses to this question fell in three general areas. The first two (below) had about an equal number of responses, while the third had a lesser number:

   1. Some interviewees felt that GIS was functioning well in Planning and should stay there.

   2. Others feel that GIS encompasses all parts of the Department and should be spread out, with some overall coordination and direction.

   3. A lesser number felt that GIS should be in IT/BCS, or at least have support and training coordinated by IT/BCS.

4. **What would be your recommendations for the optimal GIS organizational structure?**

   Answers to this question generally followed along the previous question, but respondents provided a little more detail about how GIS should function in KDOT. The predominant theme is that GIS operations should be distributed out to the business units that collect and use data, but that there needs to be some central direction and coordination. Staff feels that GIS needs to be business oriented, not technology oriented. The central coordination can come from planning, IT/BCS, or a steering committee. IT/BCS should understand GIS and provide the support needed by the business units.

5. What would be the most efficient method to provide training or guidance to staff for learning about GIS capabilities?

There were a number of ideas about training. A single method did not emerge, but several themes became apparent about training and how it should be done. These are summarized below:

- *Have the GIS infrastructure in place before training*. Staff strongly feels that they must have access to and be able to use the GIS tools immediately following training.

- *Education and awareness before training*. The Department and its staff must be aware of GIS and what it can do prior to training. Enthusiasm and direction for GIS are vital to carry training momentum. This may take the form of introductory training for all staff (GIS 101).

- *Flexible training*. Classes should be small and for selected individuals. There should be different levels (multi-tier) of classes – Management, User, Maintenance/Editing.

- *Focused training*. The classes should focus on the business processes of KDOT or the individual unit/section, rather than a general software training class.

Appendix B - Situation Analysis

Data Sharing

KDOT – State Agencies

KDOT's GIS operations have not been well integrated to this point with other GIS efforts at the state level. There are, however, significant efforts being initiated to promote data sharing and coordination among state agencies. The focal point is the state Data Access and Support Center.

KDOT – Data Access and Support Center (DASC)

DASC was created by the Kansas GIS Policy Board in 1991. The organization reports to the Technical Advisory Committee of the GIS Policy Board. DASC's primary activities have included coordination of gathering and dissemination of statewide GIS data. This has been supported through specifically funded and sponsored projects, such as development of an NSDI (National Spatial Data Infrastructure) clearinghouse node function, a Kansas Collaborative Research Network (KanCRN) grant, and the KanView WWW site.

The function of DASC most pertinent to KDOT's GIS program is the involvement of the organization in the NSDI clearinghouse concept. To meet the goal of this effort, DASC is working with collection and dissemination of state GIS datasets that are accompanied by metadata descriptions and which meet certain standards. As part of meeting the goal of practical implementation of the NSDI concept, there are seven proposed core GIS data layers to serve as a National Digital Geospatial Data Framework for the NSDI. A transportation layer is one of the seven datasets. DASC is currently gathering (and would like to complete for its clearinghouse node) data that meet the seven-layer requirement. As a complement to this work, a GIS user survey was circulated to key personnel in state, regional, and local agencies throughout Kansas. The highest priority identified dataset was transportation (road centerlines). Thus, there is a clear desire for significant use of KDOT's transportation data outside of the Agency.

Another important part of DASC's support and provision of GIS data is standardization of GIS data layers and provision of accompanying metadata. With the support of DASC, a Kansas GIS Standards Task Force was established in 1995 to promote development and utilization of various standards. The accomplishments of the Task Force are detailed in a succeeding section, but mention is made here to emphasize the close connection between DASC and statewide standards development. Because this work may involve standards development for GIS transportation layers, KDOT can be correspondingly expected to be increasingly involved with DASC in this area.

KDOT – Other State Agencies

While DASC is the most active GIS body at the state level in Kansas, there are additional agencies that have GIS interests or have begun GIS efforts. DASC has been substantially supported through funding by the Kansas Water Office, which has been conducting GIS projects. Other state agencies that may be potential partners with KDOT on projects or data sharing could include the Department of Health and Environment (environmental response, water quality, remediation), the Department of Wildlife and Parks (protection programs, wildlife resources monitoring), Kansas Water Office, and the Department of Agriculture, Division of Water Resources (natural resources, riparian and wetland protection, watersheds), Kansas Highway Patrol (safety, accident monitoring and locating), and Kansas Geological Survey.

KDOT – Federal Agencies

KDOT's primary GIS involvement with the federal government is evidenced by the Highway Performance Monitoring System (HPMS) reporting requirement. Each state DOT is required to provide updated graphics and data layers to FHWA for evaluation of the condition of state highways. Data items are specified and must be supported by field-collected data. In addition, FHWA has recently mandated use of its LRSEDIT program to apply linear referencing to the graphic networks upon which collected data can be displayed.

Other than HPMS reporting, there are no additional GIS-based products that must be provided to federal agencies. Several federal and national GIS transportation standards initiatives are in progress, however. These are discussed further in a later section.

KDOT – Local Agencies

Much of the momentum currently driving demands for statewide GIS data coordination and sharing is provided by local and regional agencies. In Kansas, municipalities, regional planning agencies, and MPOs are interested in obtaining GIS-based transportation data from KDOT. While this has been accomplished in an *ad hoc* manner in the past, it has become increasingly difficult to accomplish such sharing with diminished personnel resources and dissimilar GIS software being used. Nevertheless, these requests can be expected to grow. A significant new requirement for interaction will be with regional and ITS projects, where the needs for accurate and complete road data from KDOT will be significant. DASC's role in KDOT-local Agency interaction needs to remain prominent.

Standards

State GIS Standards Efforts

DASC's participation in the NSDI clearinghouse node project includes gathering data that can be described with metadata and which meets certain criteria for standards. The GIS Standards Task Force adopted a Kansas GIS Metadata Standard in 1996 that is mandated to apply to all GIS data at state agencies and academic institutions. To this point, there are state standards documents for cadastral and address-related data. Because the State GIS Strategic Plan called for the development of a Kansas Geospatial Data Framework (mirroring federal efforts), transportation data will be included in standards development. During 1998, work began on such a standard, and a final transportation standard is scheduled to be in place by the First Quarter of 2000. Much of the content of this standard may be based upon work being done at the federal level through the Federal Geographic Data Committee (FGDC) and the NSDI initiative.

Federal/National Standards Efforts

Although not specifically a state "standard," another issue for KDOT to consider in data sharing will be its Intergraph GIS product orientation. Most GIS users around the state use ESRI products (with a few AutoCAD Map users in the mix). While data translation algorithms among various software platforms have improved, this ability is not seamless. Much of the work at federal levels is addressing how to represent and store spatial data elements so that the type of GIS software utilized is not a barrier to data sharing. There are several aspects of this standard at work, discussed in the following sections.

FGDC/NSDI – NSDI Framework Transportation Identification Standard

Representation of transportation data feature types is currently being examined at national levels through the FGDC, the NSDI program, by GIS-T groups, and others. FGDC and the NSDI effort are closely aligned in creation of standards for transportation data types. FGDC was established in 1990 to facilitate data standards development and data sharing at the federal level. In 1992, a Ground Transportation Subcommittee was formed specifically to address these issues as related to transportation data. By 1994, the NSDI initiative was established through a Presidential Executive Order. NSDI calls for development of a framework to contain seven main spatial layers (mirroring Kansas' version), including transportation. These layers are to serve as a dynamic "patchwork quilt" of data of varying sources, accuracies, and scales. The goal is to provide these data according to accepted, well-defined standards (and with accompanying metadata descriptions) to promote sharing among users, and to update data with higher quality information when available.

The NSDI Framework Transportation Identification Standard is embodied in the form of a second working draft document (dated 5/20/99). The goal of this standard is to define a collection of transportation segments independent of scale, representation, and topology. Most importantly, the scales for which the Transportation Standard is intended would typically be from 1:12,000 to 1:24,000 – relevant to statewide areas and organizations such as KDOT. The Transportation

Standard is based upon assignment of a unique identification code for each segment known as an **FTSeg** (Framework Transportation Segment) that is defined by **FTRP**s (Framework Transportation Reference Points). The Transportation Standard specifies use of these objects to facilitate their transfer among multiple types of users, software, and data models. The Transportation Standard is **not** a geodetic or linear datum, although this object model can accommodate such datums. The Transportation Standard is more limited, being of a coarser character than specific models designed for linear referencing. The Transportation Standard model unique object identifier code is defined by a “data authority” responsible for maintaining segments, a feature type, and an 8-character numeric code. Additional data in the model describe segment representative type, i.e., logical (some abstraction) vs. physical (geometrically correct), connectivity (implicit vs. explicit), and status (active, retired, etc.).

For KDOT, there are several relevant aspects of the NSDI Transportation Standard. First, it is not specifically a network-based, topological model; therefore, for KDOT to use the Transportation Standard model as a transfer mechanism to other agencies (such as MPOs), topological connectivity definitions are not important. This model may therefore hold significant promise as a mechanism for flexible inter-platform data sharing with DASC and other relevant agencies. To be tied into a true graphic network representation, the Transportation Standard model data must be linked to a separate attribute table that contains shape point coordinates. This could be done to still easily allow “standard” GIS processing (including HPMS). Second, through its definitions of implicit and explicit linkage, the model would support initial creation of a “base” set of links (for KDOT, major roadways) that could be later updated with additional links (i.e., local roadways) without editing of the original dataset. This flexibility could again promote data sharing with other entities as well as accommodate efficient updating of KDOT’s main roads network with local roads. Finally, although there remain several unresolved questions about the Transportation Standard (such as whether it does actually include some topological connectivity), it may become the main national standard for transportation elements. The Spatial Data Transfer Standard (SDTS) effort has included work on a Transportation Network Profile element, but the development halted in 1995 due to barriers in element definitions that could not be resolved.

Will the NSDI Framework Transportation Identification Standard become an important part of KDOT’s operations? It remains too early in the process to make a definitive judgment. However, KDOT staff should remain closely apprised of developments with the NSDI due to DASC’s interest, and be open to opportunities that may arise to test the standard on a prototype basis.

FGDC – Geospatial Positioning Accuracy Standards

Another set of FGDC standards covers positional accuracy of spatial data. Three endorsed standards include methodology for reporting spatial accuracy, specifications for geodetic control networks, and creation of a National Standard for Spatial Data Accuracy (NSSDA). The latter specification is designed to replace the existing National Mapping Accuracy Standard (1947) and the ASPRS Accuracy Standards for Large-Scale Maps (1990). The new standard specifies use of the NAD83 horizontal datum and the NAVD88 vertical datum whenever possible. Data will meet the new standard when 95 percent of a set of candidate points meet confidence level test thresholds for horizontal and vertical accuracy. The tests are to be based upon RMSE (rootmean-square error) equations to estimate positional accuracy of candidate points as compared to identical points already determined to be of higher accuracy.

These standards have significant potential meaning for KDOT relative to statewide surveying efforts (including location of section corners and any GPS-based data collection) and DASC's work. Questions of how to tie KDOT's control references into a statewide network may be at least partly answered by use of this standard. Again, if KDOT's control points can meet this standard, corresponding graphic representations of KDOT roads and other features may then meet FGDC/NSDI requirements. Much more consideration of this issue is needed by interested groups in Kansas to determine how KDOT may participate.

Open GIS Efforts

Complementing national efforts for data standardization, interoperability standards for GIS and data platforms are being developed. This emphasis is the main focus of the "Open GIS" movement, centered on the OpenGIS Specification initiative being coordinated by the OpenGIS Consortium and other involved entities (including the major GIS software vendors). "Open GIS" can be defined as "transparent access to heterogeneous geodata and geoprocessing resources in a networked environment" (OpenGIS Consortium, 1999). The OpenGIS Consortium is a group of public and private entities that serves as the creator and manager of industry-wide open GIS architectures for interoperable geoprocessing synchronized with supporting standards.

The OpenGIS Specification was developed between 1994 and 1997 to promote promulgation of spatial data interfaces that support access and queries among dissimilar software and data models. There are four separate specifications, for CORBA, OLE/COM, Internet, and ODBC interfaces. The OpenGIS Specification was designed to continue the goal of interoperability as initiated through development of the SDTS. While the SDTS facilitates exchange of data between dissimilar systems through a transfer standard mechanism, the process requires off-line, time-consuming batch processing. The OpenGIS Specification is designed to perform this work through on-line conformant interfaces in middleware, componentware, and applications programs. The OpenGIS Guide document is currently in its third draft version (6/98), where the OpenGIS Specification is described.

Briefly, the OpenGIS Specification is a potential enabling technology for the NSDI, and is not in and of itself a data standard. Rather, it defines standard primitive data types and operations upon them in a geodata model. This has been formulated for Simple Features Specifications, which have been the main starting point for involvement by the major GIS and database vendors. In Fall 1997, vendors including Intergraph, ESRI, MapInfo, Microsoft, and Oracle cooperated to demonstrate a successful usage of the OLE/COM specification. The same GIS dataset was retrieved and displayed in real-time using a combination of Intergraph, ESRI, and Oracle Spatial products. Intergraph's GeoMedia product line highlights OpenGIS Specification compatibility because of its object-oriented design. ESRI's Spatial Database Engine (SDE) product is a middle application server that also supports the OpenGIS Specification through its own interfaces and through compatibility with the Oracle8 Spatial software. This access interface was successfully tested in March 1999.

The significance of the OpenGIS Specification effort to KDOT is likely to become clearer in the future. ESRI has stated that all vendors will require a significant time investment to continue work with these specifications. The relevance for KDOT may be seen in the potential data sharing from its Intergraph platform with other software, most notably ESRI products. Since the state is heavily oriented to use of ESRI GIS software, this requirement will only become more critical, especially if KDOT coordinates increasingly with DASC. There may be a potentially fertile opportunity to consider this arrangement in terms of a pilot project that could involve the vendors themselves.

Basemap Development

The development of GIS largely began in the 1960s with Canadian initiatives to develop a national program called CGIS. Throughout the 1970s, GIS development was constrained by the massive costs for technology and lack of available spatial data. Development of personal computers in the early 1980s was accompanied for a time by corresponding advances in capabilities of mainframe and minicomputers, which most GIS software utilized. During the 1980-1990 period, growth in spatial databases and digital maps occurred steadily but slowly. Federal developments such as the Census DIME (and later TIGER) digital mapping initiative spurred GIS growth nationwide. There was a significant time lag between when PCs entered the market and when their processing capabilities became suitably robust for serious GIS work. By 1995, desktop GIS had become feasible, and spatial datasets were becoming more accessible. Corresponding widespread deployment of on-line services through the Internet has brought GIS in some form to nearly all that desire access.

Why offer a capsule synopsis of GIS history? Because it is appropriate to view the present GIS situation in Kansas in terms of past development. The present-day efforts to coordinate data access and availability statewide will help to promote more widespread use of GIS throughout Kansas. Integration and sharing of data is not yet mature, however. Therefore, a rather basic question still should be considered: What are the advantages of using GIS? For the Kansas DOT, the following list encapsulates some of the major potential benefits:

- **Expanded capabilities.** New applications, tools, and data for decision-making can provide extensive benefits to GIS users and customers. Such enhancements may include integration of elements, implementation of new technologies, field use of GIS, and additional data types.
- **Improved procedures.** More efficient operations can be promoted. Improved, easier-to-use tools can be developed for analysis, display, and output. Enhanced visualization capabilities can often result.
- **Dollars/personnel time/other related benefits.** In addition to cost savings that can be shown over time, there are indirect savings in other “resources” that can occur from actions to be implemented. For example, new and improved GIS applications that are safety-related could help to save lives and property.
- **Improved delivery of services.** Expanding the “audience” for GIS requires a corresponding improvement in the delivery of GIS services. New methods such as the Internet and Intranet can be employed to assist in these processes.
- **Better responsiveness/awareness.** Faster response to customers, including the general public, can be realized. This process, in turn, can promote awareness of GIS capabilities.
- **Higher quality services.** Quality of products and services can be enhanced through use of accurate GIS data and graphic elements.
- **Organizational efficiencies/technology transfer.** Organizational benefits can be realized with implementation of GIS-related actions. Integration of GIS with other operations (cartographic production, for example) can have major effects on how business units conduct business.

- **Expanded and improved customer support and training.** Provision of technical guidance can be important to support an expanded GIS customer base. Improved and extended training processes can help to accomplish this.
- **Better standardization/data sharing.** Development of common approaches, data formats, graphics structures, and procedures is needed to facilitate data sharing with GIS partners. Codification of best practices and standard formats can facilitate data exchanges.
- **Ability to keep pace with technical developments.** Monitoring technical trends in the GIS and computer fields is vital to its effectiveness. Corresponding technological developments throughout transportation (e.g., ITS) can be integrated with GIS operations.
- **Improved ability to meet federal requirements**. GIS can also help to support a more efficient, effective methodology to meet federal reporting requirements.

How will KDOT fully realize these benefits? There are two primary actions that must occur to ensure a successful GIS program. First, appropriate basemap layers must be available and accepted as a standard. This implies that accuracy and detail levels have been agreed upon. Secondly, data integration must occur. Linkage of KDOT's databases to GIS must succeed, or else the real decision-making power of GIS will not be fully realized.

Primary KDOT basemap issues include **scale, accuracy, level of detail, and linear referencing system**. Determination of how these interrelate and function will affect how successfully GIS can be integrated with KDOT non-graphic databases as well as data external to the Agency. As described in previous sections, there are state initiatives to promote GIS standardization and data exchange. KDOT's ability to meet these goals successfully will depend in part upon the Agency's commitment to participate in these initiatives. Costs and benefits of doing so must be weighed with available funding and personnel resources. More discussion of this issue will be provided in the "internal factors" section.

Impact of Other Technologies

Videologging

Many state DOTs have invested in videolog technology to assist in visualization and evaluation of roadway conditions. Often this is accomplished in conjunction with deployment of roadway inventory vans, which are equipped with sensors that automatically detect and report pavement conditions. A key to effective, integrated use of this information is to link video frames to a locational identifier. If this can be done (for example, through linear referencing), then both video and collected data for roadways can be directly accessible through a GIS interface. The power of combining these capabilities through GIS should be evident for decision-making support. In a similar manner, data linked to straight-line diagrams (SLDs) can be automated to be accessible via GIS. Some commercially developed GIS interfaces provide a method to view these data together.

For both of these tools, location referencing is needed to link imagery and data to GIS. In addition, data management is critical. For such a statewide application, the amount of data and volume of images or video may be substantial. To reduce this overhead, some implementations of a GIS-videolog link have been built upon static images sampled from a video stream. Both image storage capabilities and image compression techniques are improving, and can be expected to continue to become more efficient.

Global Positioning Systems (GPS)

The use of GPS with GIS has greatly altered the complexion of data accuracy and precision. For KDOT's GIS program, GPS has two major implications. First, positional data collected through GPS can be expected to improve the accuracy and precision of the GIS base roadways layer. Second, GPS-collected data on events or features such as traffic accidents, bridge locations, wetland boundaries, and driveway locations will provide new, highly precise data for addition into GIS. Each of these aspects will be discussed separately below.

Whether GPS positional data is collected through a pavement van or another source, procurement of more precise coordinates for roadways is obviously of interest to KDOT for the GIS base layer. How is this updating and replacement process conducted? Because KDOT's existing base layer does contain a linear reference scheme, any new features must not only be graphically replaced, but the updated geometry requires that segments must be capable of using the more accurate, remeasured lengths. Depending how related data has been collected, updating of linear references in associated databases may also need to be performed. This can have major implications for database editing and maintenance needs. There are existing GIS algorithms to assist in performing this updating, but some programming support may likely also be required. Another issue relates to sources of GPS data, and the scale at which it has been collected. Inside KDOT, but more likely with external agencies, the level and quality of GPS data has the potential to vary. Incorporating and integrating updated coordinates from multiple sources could be a major task. However, GPS data from local agencies may offer a significant source of quality graphic data for local roads, for example. Coordination with DASC may be one way to address these concerns.

The types of GIS-compatible, GPS-collected data that may become available could be substantial across Kansas. Whatever the features, coordinates collected will need to be matched to the base GIS roadway layer. There are GIS tools designed to automatically associate such point data with linear roadway features, and derive a linear reference. Depending upon scale and precision, however, there is the potential to automatically match point features to the incorrect linear feature. Such could be the case in an interchange area, for instance. Therefore, some post-processing quality control checks may be required to fully utilize GPS data in GIS.

Intelligent Transportation Systems

The development of ITS projects in the United States is truly impressive. Federal budgets for such work have allowed ITS to expand rapidly even to medium-sized urbanized areas. In Kansas, the two main projects are in Kansas City (including the Missouri portion) and Wichita. For KDOT's GIS involvement, coordination is needed in provision and use of digital basemapping. This aspect of ITS is related to map precision and accuracy issues, as maps may be used in ITS projects to locate infrastructure and incidents on large-scale (small area) maps. Individual lane depiction and data collection may even be required. Real-time capabilities are also often part of ITS, and such information gathered could be used by KDOT. Specialized applications such as vehicle tracking and real-time road condition monitoring have potential for dissemination over the Internet. These types of applications may be dependent upon linear referencing, address matching, and GPS data collection.

Another aspect of ITS that may affect KDOT's GIS is the need for local streets to be incorporated on digital maps. This will most certainly be desirable for both the Kansas City and Wichita projects. How these roads will be generated and/or integrated with KDOT's basemap will likely need to be examined.

Internet

Information delivery using Internet technology is growing rapidly. In turn, ways that information can be delivered through the Internet is also increasing. The type of information that KDOT can deliver through the Internet ranges from static reports and lists to near-real-time road and traffic conditions. The information can be conveyed as text pages, or as visual maps or video images. In addition, an organization such as KDOT frequently employs an Intranet for intra-organizational applications, using Internet technology but usually in a more secure environment. KDOT is taking advantage of the Internet (and Intranet) in several ways, and must continue to look at the Internet as a primary path of information delivery.

The Internet (and Intranet) can be used to benefit planning agencies such as MPOs, motor carrier and other traveling constituencies, KDOT district offices, and the general public. Examples of Internet applications include the publication through a map interface of traffic counts, maps showing construction, obstruction, or detour areas, and construction project Web sites. The Road Condition and Reporting System, and other planned Internet applications, provide a good foundation for increased delivery of information through the Web. The Department will have to remain cognizant of Internet and Web advances, and take advantage of them when appropriate.

However, it should be remembered that while the Internet can be a primary information path, it is certainly not the only method that can be used. Many possible users of KDOT information, including the public, may have no access to the Internet, and they must rely on traditional hardcopy or broadcast delivery. The dissemination of GIS work through maps and map boards will still be needed for some time to come.

Internal Factors

Kansas Comprehensive Transportation Program

The Governor's mandate to the Committee producing the CTP was to "Look beyond the traditional emphasis on roads alone." In particular, the plan places emphasis and establishes goals and funding for air, rail, mass transit, and partnerships with city and county government. The mandate of the CTP for KDOT will be to devote more energy and resources to these areas.

The Comprehensive Highway Program (CHP) and KDOT's efforts in implementing the CHP were praised in the CTP report. KDOT is encouraged to take the lead on the implementation of the CTP, in particular those areas receiving higher visibility. City and county governments will also be asked to lend their support. Both the state and city/county governments will require additional resources to meet these initiatives.

Of particular note in the CTP were:

- In aviation, the Kansas Airport Improvement Program will provide more funding for the state's airports, particularly the smaller community airports. This represents a re-emphasis on air transport in the state, and especially the economic benefits that may derive from increasing air transport.
- In mass transit, annual funding was increased from $1 million to $8.8 million. This represents a significant focus on mass transit, with emphasis placed on the ability of mass transit to support 'Welfare to Work' initiatives.
- In rail, funding was increased to $5 million a year, with importance placed on the state's shortlines. The shortlines are envisioned to carry more local freight, reducing road traffic.
- In highway, the two main areas were safety and fostering economic growth. The Core Program will focus on preservation and modernization of the current road network, while the Expansion Program will focus on new roads.

The increased emphasis on the non-highway elements in the CTP will have an impact on the KDOT GIS program. The GIS program is now focused on the 10,000-mile state highway system. Data layers that make up the important elements – air, rail, and transit – will have to be incorporated and used in the GIS. In addition, many more roads will need to be added into GIS to support local partnerships. GIS should help KDOT support these transportation initiatives.

LRS Study Report

The LRS adopted for the CANSYS II program is also designated as the KDOT standard LRS. However, business functions that use other referencing methods are not required to change their practices at present. These LRMs should be reviewed to determine if they can be made compatible or usable with the standard LRS. The accommodation of these LRMs with the standard LRS is very important to the goal of information sharing within the Department. The users of the various LRMs need to share data with each other as well as with other databases in the Department. In addition, the LRS needs to accommodate LRMs used by outside groups, such as cities and counties.

The Route Identification in the standard LRS (lrs-key) can accommodate local roads or other non-state highway roads. This is important as the GIS expands and other roadways are added to the existing (10,000-mile) GIS basemap.

Established Priorities within KDOT

Department-wide Priorities

The Department is implementing RDBMS technology for many of the business processes and data sources. Some of this work includes conversion of legacy data and application systems to Oracle RDBMS-based applications, and other work involves development of new data applications using RDBMS. One of the intents of this work is to improve access to information for KDOT staff.

As described above, the Department must also respond to the CTP. The Department is increasing resources, including staff, in order to meet this challenge.

The Department must also work along with other programs and initiatives in the state. This includes coordination on information systems technology, such as application software used, and on being able to integrate various types of data. KDOT must be able to supply data in a usable format to other state agencies, to local governments, and to other data users.

GIS Priorities

The primary priorities of GIS in KDOT identified as part of the GIS Strategic Plan process have all centered upon access to information. Staff strongly indicated a need to find, access, and query various databases, and also make that information available through maps, reports, and Web applications. Staff feels that GIS can and should serve as an easy-to-use interface to many of the Department's information sources. The task of GIS within the Department is to provide this access. The implementation of RDBMS technology in the Department is a step towards providing this information.

Other GIS priorities include the incorporation of additional roads and data. KDOT must meet the data needs of other groups and provide information in a usable format. The GIS basemap is to be expanded from the current 10,000-mile system, to eventually cover all the public roads of Kansas. Efforts are also underway to add information about the state's rail infrastructure. In addition, efforts are underway to provide this information in formats used by various software programs.

A third area of GIS focus is on application development. This effort is designed to meet the data access needs of Department staff, as well as the public, by providing applications geared toward specific functions and operating through a visual map-based interface.

Application Priorities

The application priorities identified in the Strategic Plan process follow the general GIS priorities. These applications are designed to provide data to users through the GIS and build upon the Web GIS work started with the Road Condition and Reporting System. Such tools allow remote updating and viewing of information and increase the public's use of KDOT information. The priorities also address the "opening up" of database systems, by supplying a common GIS interface to databases and development of conversions of information from legacy systems to RDBMS.

Available Resources within KDOT

The development of GIS programs and processes within the Department has been slowed by a lack of personnel resources. Much of what had been envisioned for GIS has been slow to develop because of staffing constraints. In addition, the GIS basemap construction and maintenance has required significant resources, leaving little for development of GIS applications.

However, the adoption of the CTP has led to an increase in funding for the Department, and the importance of GIS in helping the program to succeed has resulted in an increase and focusing of resources for GIS. A more aggressive GIS development schedule has been initiated, and these programs are designed to address the identified priorities. In addition, the basemap effort is receiving dedicated resources to increase its coverage to address the CTP and state GIS initiatives.

Enablers and Inhibitors

GIS Basemap

Enabler: The GIS basemap has been identified by many staff in the Department as a very strong enabler for GIS. The existence of the basemap and the LRS it supports have contributed greatly to GIS efforts within the Department so far, and provide a good foundation upon which to build applications. The Department has made a significant investment in the basemap.

Inhibitor: The basemap scale leads some staff to question how well it will work for other applications in GIS, including the use of GPS for data collection and as an LRM. Another concern is the completeness of the basemap, that is, the extent of the road network and other layers that are contained. The CTP will require a more extensive GIS base. Another inhibitor is the portability of the basemap. It is in Intergraph format, and KDOT and other users have found it difficult to use the basemap with other programs.

LRS

Enabler: The Department has a standard LRS and it is implemented in the basemap. This is an important enabler for GIS. The LRS allows many of the Department's data sources to be represented on a GIS map. The presence of the LRS is very important when showing Department information to legislators, for instance. The LRS does work with multiple LRMs.

Inhibitor: The present structure of the LRS contains two inhibiting factors to GIS. The LRS is implemented on only 10,000 miles of state highways. Large amounts of information (crash data, for instance) need to be referenced and shown on roads off this primary system. The LRS also does not accommodate the temporal factor (representation of historical information). Road assets change over time and frequently a historical view of roadway conditions needs to be accommodated. Currently, KDOT maintains segmented files for each year for linking attribute data to electronic maps for GIS analysis and presentations. This method of storing copies of the basemap (and attached LRS) to use when historical analysis is requested will be cumbersome to use and manage as GIS growth occurs.

GIS Staffing

Enabler: The strongest enabler mentioned during the GIS Strategic Plan interviews is the current expertise of the GIS staff. The staff is very well thought of and the success of GIS so far is largely attributed to them. Another enabler is the imminent addition of new staff, which should provide focus on GIS issues in particular areas.

Inhibitor: Staffing resources will continue to be an inhibitor. Department staff has identified many possible applications of GIS, more than the current or projected staff can accommodate.

Intranet/Internet

Enabler: The current and proposed use of the Internet for GIS applications is an enabler. The Road Condition and Reporting System and the Construction and Detour Reporting System will distribute GIS out to the districts, motor carriers, and the public, and provide all of them with useful functions. The continued focus on these types of applications is important. The Department has acquired the software tools to support this, and is developing the expertise for programming and managing these types of applications.

Inhibitor: An inhibitor to the use of the Internet and Intranet is the existence of many of the legacy systems. These systems house much of the information that is important to distribute out through the Web, and these data must be converted for use.

Team Building/Partnering

Enabler: The existence of the GIS Subcommittee is an enabler for GIS within the Department. A successful GIS is the culmination of hard work spread across the different business groups. GIS must be visible to the rest of the organization. It must be a true partnership, including the Bureaus of Transportation Planning and Computer Services, who believe in GIS and provide the resources to make it happen. Data owners who provide the information about transportation systems must also be prominently involved. KDOT must keep in mind that implementing a GIS affects the entire organization. Therefore, it is essential that the Department develop a “center of in-house knowledge” to build a consensus on a number of GIS issues as early as possible. The simple practice of meeting regularly is essential to positive communication among the GIS partners. GIS developers, users, and customers should be regularly discussing technologies, operational concerns, schedules, and upcoming activities. For example, the Department recognizes the need to support more than one GIS software platform, and is making plans with the basemap to accommodate the users of products such as ARC/INFO and TransCAD.

Inhibitor: With any team or partnership one must expect turf battles and work hard to prevent them. This is one of the greatest challenges in development of a GIS. Coordination and group success must be realized if the Agency wants the GIS to be successful. The solution is to involve everyone in the process, decision-making and successes. A committee structure will facilitate agreement on issues regarding policy and procedures.

Education and Training

Enabler: A key to success with any changing technology such as GIS is education and training. Many staff indicated that training on both general and specific GIS principles and operations would be crucial. KDOT’s core GIS staff must identify opportunities to educate the entire Department on GIS. Education should be seen as a long-term investment for the Department. One of the most important factors for success is to view every inquiry, status report, presentation, staff meeting, etc. as an opportunity to educate the staff regarding GIS and its potential.

On the other hand, training which typically improves the individual’s skills that relate directly to an operational function should be reserved for specific individuals that are currently working in the

GIS environment. Training is very specific to a particular technology and will be forgotten if not used in routine tasks.

Inhibitor: An inhibitor is the current lack of knowledge among many staff as to what GIS is and what it can and can not do. A suitable level of training and education should be provided to the appropriate staff. Some agencies assume that individuals will train themselves on GIS on their own – this can be helpful, but is not a complete solution. The philosophy should be to provide appropriate levels of GIS education without confusing, overwhelming or boring the staff.

Data Sharing and Integration

Enabler: KDOT has a large amount of transportation data. All staff uses these data and many have expressed a need to access and use more information than they are now. The Department is in a transition mode of migrating databases and associated applications from the mainframe to an RDBMS and client-server environment. The use of Oracle for database solutions promises to make the needed information available to users, and provide it in a form that is GIS-friendly. Oracle databases and servers will fit well with the client-server environment, providing access to data to a larger audience of users. The use of Oracle for data serving also positions the Department well for utilizing Internet-based data applications.

Inhibitor: The data of interest to KDOT staff exist in many locations – for example, on PCs, in the CANSYS II database, and on the mainframe computers. Staff is spending too much time searching for information instead of using it. They require ready access to the data. In addition, the staff must be assured that they are using the most current information possible. The data must be periodically updated and the update cycle made available to users.

Resources and Momentum

Enabler: The initial challenge in implementing any new technology is to procure and maintain the resources. The GIS program has attempted to make the top Agency executives partners in the development of the GIS. They influence whether the GIS will be funded and implemented. The GIS staff must work closely with Agency executives, responding to their information needs with GIS products and applications. This has proven to be successful so far in building the KDOT GIS.

In addition, the GIS program must continue to show successes to sustain momentum for GIS in the Department. GIS must move at the right pace, fast enough to assure continued upper management support, but not venturing quickly into uncharted areas. The program should show success for each step, and build upon that success.

Inhibitor: The danger for all GIS programs is attempting to do too much, too soon. Many parts of the Department have made their case for GIS application or database development to support their specific functions. The GIS program must address all of these concerns, but also determine the appropriate time to do the work. This will mean elevating some projects above others. The GIS program must maintain communication with all parts of the Department and explain why particular GIS work is being done. It must also communicate when future work may be done, or what conditions need to be met to perform a specific project. All constituents need to feel that their wants and needs are being heard, and that GIS development is following an orderly track.

GIS Software Questions and Answers

Is Intergraph still a viable leader in the GIS market place for DOTs?

Intergraph maintains a leadership role in the transportation GIS marketplace. Intergraph GIS products are in use at many DOTs, including those departments that have mature and productive GIS programs (e.g., PennDOT, ODOT, DelDOT). Intergraph is committed to the DOT/GIS market; much of their development effort is focused at this particular market.

Intergraph's dominant position in the DOT market has been trimmed. This is due to a number of factors, including less reliance on Intergraph hardware products, the split of MicroStation into another company's product, and the emergence of AutoCAD as a design alternative. GIS alternatives such as ESRI have also emerged. However, Intergraph does appear to be directing their resources at the areas where they excel, and they should be able to continue as a market leader in this area.

Clearly, there are only two main players in the transportation GIS market --- Intergraph and ESRI.

Is Intergraph still an economically viable company that is likely to stay a leader in GIS related products?

While it requires a bit of speculation to answer this question, Intergraph has announced significant restructuring that will result in the creation of multiple business units that have their own profit and loss centers. The Mapping/GIS (GeoMedia/MGE) Division within Intergraph is one of its most profitable divisions. This ensures the future of the GIS division as a leader in the industry.

Is there a noticeable trend within state DOTs to switch to ESRI or something else? If so, why? Is it a mistake to use Intergraph as the "core standard" for KDOT's GIS applications yet allow other products such as ArcView to be used in specific cases where they better address the business need?

We know of no trend of DOTs switching whole-heartedly from one platform to another. There seems to be a general trend of hybrid GIS environments. Some Intergraph DOTs are acquiring copies of ArcView (e.g., PennDOT) but we also know of ESRI dominant DOTs (e.g., Caltrans) using GeoMedia Web Map to publish their ESRI data on the Web.

Other than training costs associated with supporting multiple platforms, there should be little hesitation in using other products such as ArcView "out of the box" to meet specific requirements. This can be a case of using the best tool for the job. KDOT and other DOTs have found the Intergraph GIS products to be best suited for the basemap, dynamic segmentation, and cartography applications, while other products can be used when they are better suited. This type of environment can work well if data management and/or translation procedures are well developed and maintained.

Does ESRI or some other company now have clear leadership in GIS, such that* KDOT *should consider switching?

With new, non-traditional players entering the GIS market (e.g., Microsoft and Oracle), the situation is getting complicated. ESRI has focused on proprietary technologies (SDE) and formats with diverse code base and development environments (Avenue, AML, VB) making the products problematic for enterprise-wide projects. ESRI is, however, taking steps to address this with new software releases such as ARC/INFO 8.

Will Intergraph products likely be able to sufficiently address the GIS applications that KDOT staff is proposing?

Intergraph GIS products can certainly be used for the development and deployment of both the immediate and long-term proposed applications, and these applications should perform well. None of the proposed applications require a different environment. Some of the applications, for instance, for Environmental Services, may be better supported by ESRI tools, but will still function well with Intergraph. It is instances like this that require looking for the best tool for the job, and evaluating whether a particular application should be developed with a non-Intergraph product.

Given that ArcView, etc., are also in use within KDOT; and ESRI products are widely used in other agencies, should KDOT switch to ESRI or something else? Would the benefits of such a switch outweigh the disadvantages of not switching?

Determining the “benefits” of switching would really require some extensive research. Intergraph and ESRI are the only market players that provide GIS products for use throughout the DOT enterprise and disciplines. Both software platforms have their advantages and disadvantages. The mere use of other products in other departments or agencies should not be considered reason to switch, however. GeoMedia provides robust capability in reading ESRI, MapInfo, and AutoCAD data without conversion and in multiple projections. In addition, these data can also be read within the MGE/MicroStation environment. On the other side, ESRI products can read Intergraph/MicroStation files either directly or through translation, depending on the intended use of the data.

Coordination of data between agencies and GIS platforms can be accomplished if some thought and planning is applied. KDOT or any other Agency should not switch GIS platforms because of data exchange problems.

Anything else that is relevant?

Intergraph is currently developing a new data model for linear referencing. One of its major strengths is the ability to integrate multiple routes (e.g., bus, transit, road, rail, etc.) and LRS schemes (milepoint, route/offset, Lat/Lon) in a single queryable model. In addition, GeoMedia 3.0 is to provide better capability for map-making, which is very important for end users, particularly non-GIS staff.

In conclusion, for KDOT, the Intergraph suite still remains a better choice than ESRI. Intergraph’s handling of dynamic segmentation is superior both for the end-user and the data maintenance group. In addition, one also has to consider the costs of switching from Intergraph to ESRI. The large investment in design files, IPLOT iparms, metafiles, cell libraries, font libraries, software, etc. would be very costly to re-create using ESRI tools. Investments in training would also be lost.

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Appendix C - IT Initiative Approval and Reporting Processes

IT Initiative Approval and Reporting Processes

(NOTE: Appendix C is an excerpt from KDOT's 1998-1999 Information Technology Architecture Plan.)

Purpose

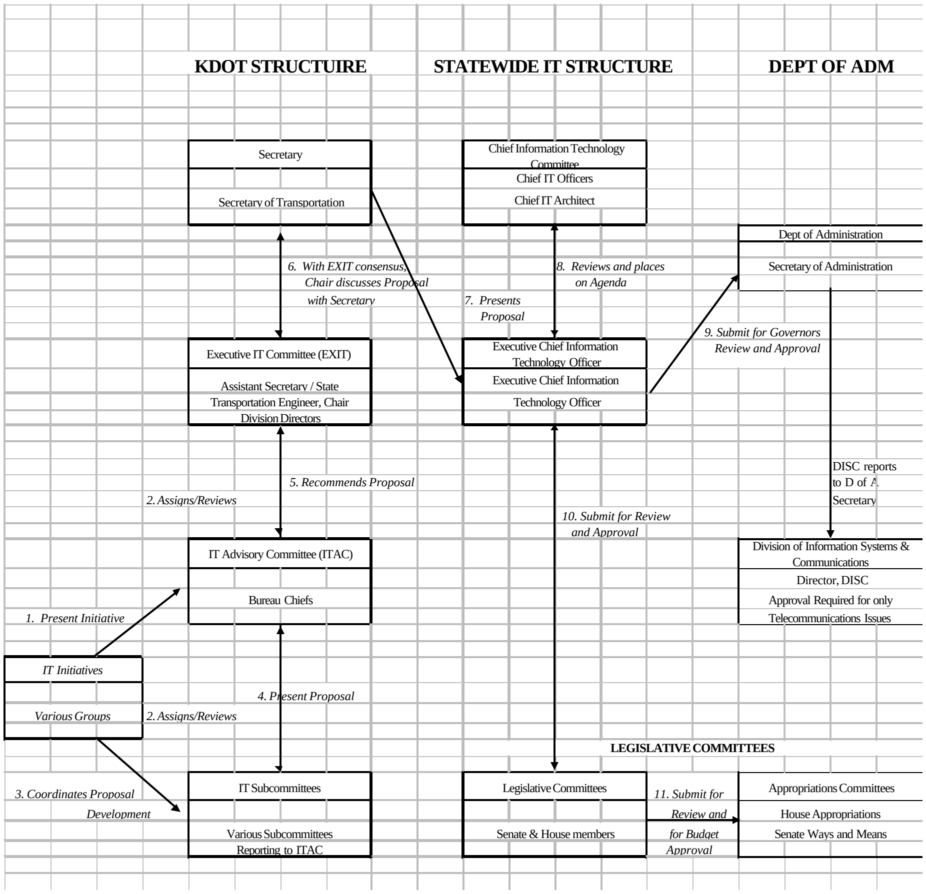
The purpose is to assess the overall technical architecture impact by promoting coordination and standardization of IT usage across the Agency.

Description

The IT Initiative Approval Process outlines the steps by which KDOT initiates, studies, develops proposals, and obtains approval of IT issues

IT Initiative Approval Process

Chart



IT Initiative Approval Chart

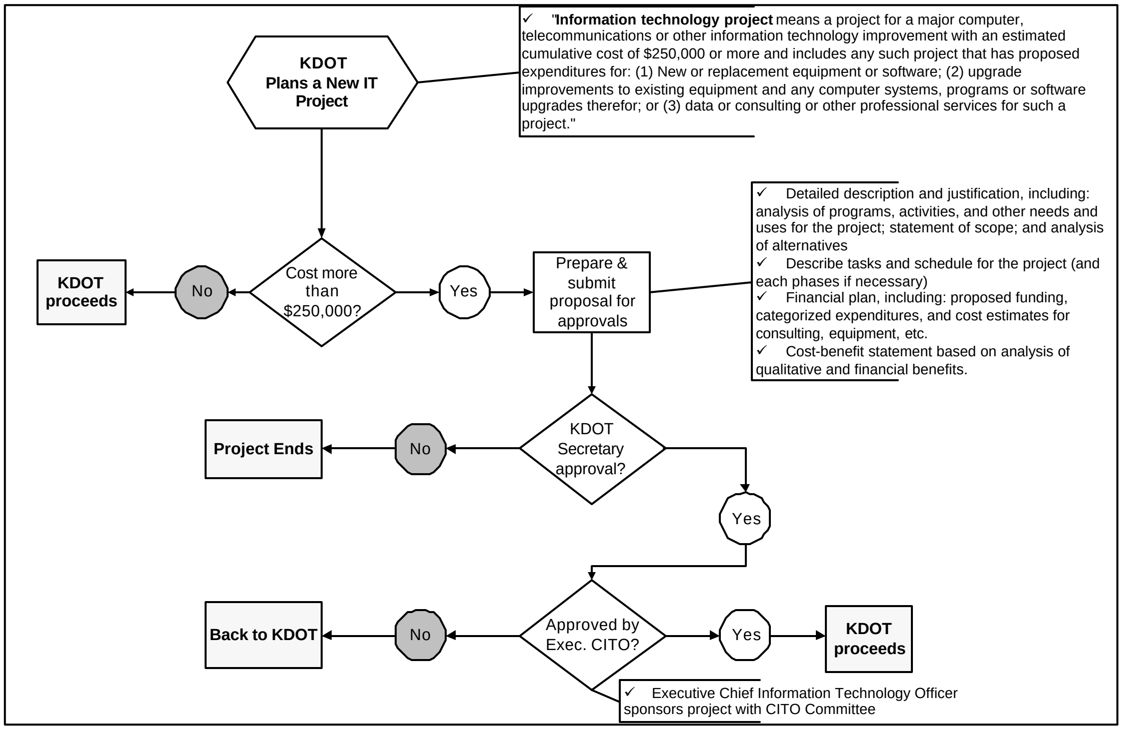
Process Description

- Various groups such as Division Groups, IT Subcommittees, Ad Hoc Groups, and Bureau of Computer Services personnel present initiatives to the ITAC or appropriate subcommittee for review.
- The ITAC reviews and assigns the initiative to the appropriate subcommittee or creates a new or ad hoc committee to coordinate the development of a formal proposal.
- The IT Subcommittee or Special Ad Hoc Committee, along with the initiator, reviews the initiative, related information, and develops a formal proposal.
- The IT Subcommittee or Special Ad Hoc Committee, along with the initiator, present the final proposal to ITAC for architecture and plan review. If directed or assisted by ITAC, the IT Subcommittee presents the final proposal to the EXIT Committee.
- ITAC does a final review. Upon consensus ITAC recommends approval or rejection of the proposal to the EXIT Committee, or returns the initiative to the IT Subcommittee for additional work.
- The EXIT Committee reviews funding and resource issues and upon consensus recommends the proposal to the Secretary for final sign-off or rejects the proposal.
- The Bureau of Computer Services member of the ITAC reviews telecommunications issues with DISC for approval as per state statute and presents the initiative to the Executive Chief Information Technology Officer.
- The Executive Chief Information Technology Officer and KDOT Bureau Chief of Computer Services coordinate the proposal with the Chief Information Technology Committee for those issues requiring Chief Information Architect (CIA) approval.
- The Executive Chief Information Technology Officer and KDOT Bureau Chief of Computer Services coordinate the proposal with the Governors office for approval.
- The Executive Chief Information Technology Officer and KDOT Bureau Chief of Computer Services coordinate the proposal with the appropriate Legislative Committees for approval.
- The Executive Chief Information Technology Officer and KDOT Bureau Chief of Computer Services coordinate the proposal with the appropriate Legislative and Appropriations Committees for budget approval.

Senate Bill 5 Review and Approval Process

Senate Bill No. 5 was passed by the legislature and signed by the governor in FY 1998. This bill established the State IT Approval, Change and Reporting processes for all projects in excess of $250,000. The following graphics provide the highlights of the bill:

New Project Approval



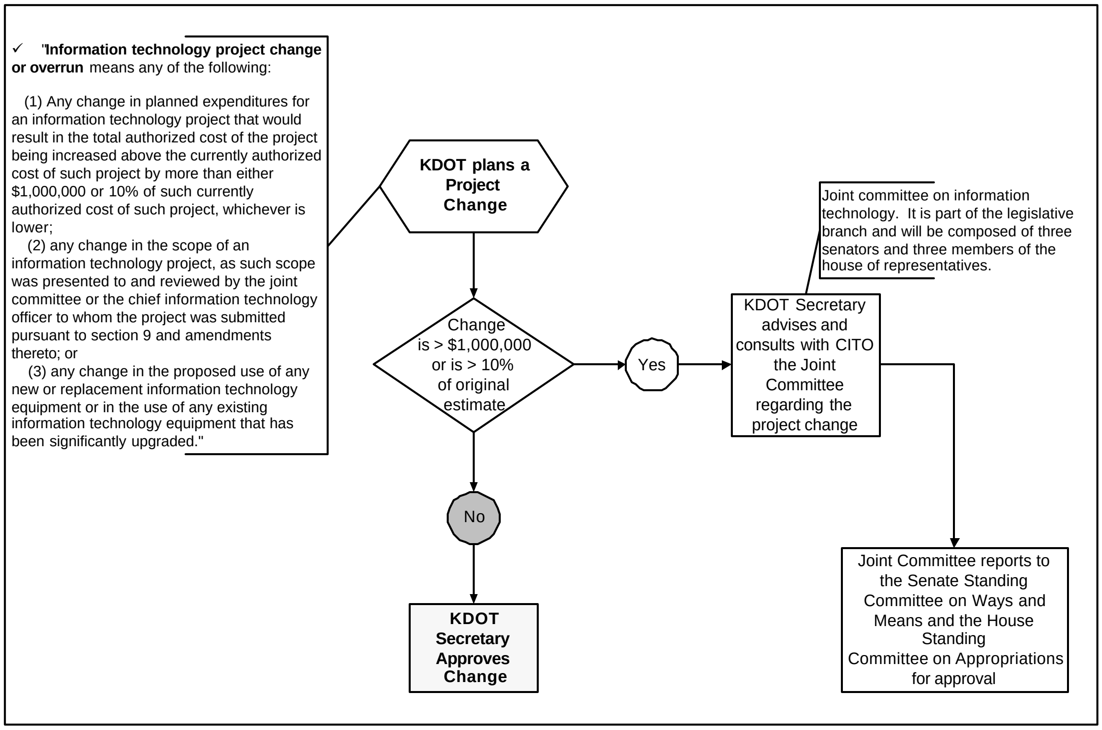
✓ "**Information technology project** means a project for a major computer, telecommunications or other information technology improvement with an estimated cumulative cost of $250,000 or more and includes any such project that has proposed expenditures for: (1) New or replacement equipment or software; (2) upgrade improvements to existing equipment and any computer systems, programs or software upgrades therefor; or (3) data or consulting or other professional services for such a project."

✓ Detailed description and justification, including: analysis of programs, activities, and other needs and uses for the project; statement of scope; and analysis of alternatives
✓ Describe tasks and schedule for the project (and each phases if necessary)
✓ Financial plan, including: proposed funding, categorized expenditures, and cost estimates for consulting, equipment, etc.
✓ Cost-benefit statement based on analysis of qualitative and financial benefits.

✓ Executive Chief Information Technology Officer sponsors project with CITO Committee

Senate Bill 5 – New Project Approval Process

Changed Project Approval



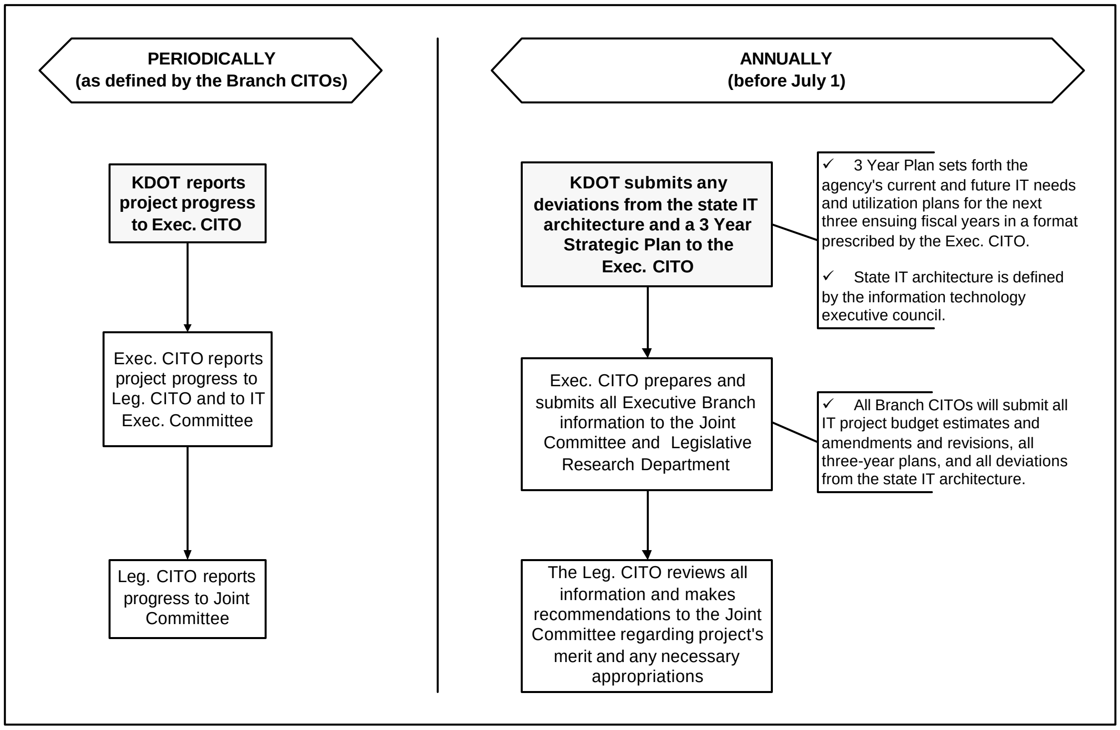
✓ "**Information technology project change or overrun** means any of the following:

(1) Any change in planned expenditures for an information technology project that would result in the total authorized cost of the project being increased above the currently authorized cost of such project by more than either $1,000,000 or 10% of such currently authorized cost of such project, whichever is lower;
(2) any change in the scope of an information technology project, as such scope was presented to and reviewed by the joint committee or the chief information technology officer to whom the project was submitted pursuant to section 9 and amendments thereto; or
(3) any change in the proposed use of any new or replacement information technology equipment or in the use of any existing information technology equipment that has been significantly upgraded."

Joint committee on information technology. It is part of the legislative branch and will be composed of three senators and three members of the house of representatives.

Senate Bill 5 – Changed Project Approval Process

Project Reporting Process



Senate Bill 5 – Project Reporting Process

Participants

- **IT Subcommittees**.
- **Information Technology Advisory Committee (ITAC).**
- **Executive Information Technology Committee (EXIT).**
- **Secretary of the Department of Transportation –** Department of Transportation Chief Executive appointed by the governor.
- **Executive Chief Information Technology Officer (CITO) –** The Executive Chief Information Officer position was created by the legislature in Senate Bill 5 to review and approve IT application and technology projects for the executive Branch.
- **Information Technology Advisory Board (ITAB) –** A sub-group sponsored by the CITO made up of IT Managers from the major state agencies that focuses on specific issues as directed by the CITO.
- **Chief Information Technology Architect (CITA) –** Senior State IT Architecture position: reports to IT Executive Council.
- **Appropriate Legislative Committees –** Joint legislative committee to review computer technology budget issues.
- **House Appropriations Committee –** A standing House of Representative Committee responsible for the review and approval of appropriation bills.
- **Senate Ways and Means Committee –** A standing Senate Committee responsible for the review and approval of appropriation bills.
- **Division of Information Systems and Communications – Department of Administration –** organization operating the centralized state data center and the Kansas Wide Area Information Network (KanWIN).