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Chapter 6

Implementation

6.1 ITS APPLICATIONS

This section focuses on the implementation of components of an integrated Intelligent Transportation System for the Wichita area. This implementation plan is based on the system architecture developed and described in Chapter 4, the technologies discussed in Chapter 5, and the recommendations made by the Project Steering Committee.

Short, Medium, and Long Term Priorities

The short, medium, and long term priorities for the transportation system in the Wichita area correspond closely to the short, medium, and long term ITS user services identified in the User Service Plan and discussed in Chapter 3. These priorities are reflected in the implementation schedule discussed in this section.

Short Term Priorities

Priorities for the short term focus on existing problems and identified needs. Thus, priorities include the need to respond to incidents, which account for most of the congestion in the Wichita area, and the need to identify locations of recurring congestion.

Short term priorities would be met by a number of activities including implementation of a freeway surveillance and management system in selected corridors in the Wichita area and coordination of the traffic management system with the use of arterials for diversion. It is recommended that the City of Wichita, in cooperation with KDOT, initiate activities that would support the use of local arterials as alternate routes to the freeway. Activities include determining appropriate timing plans for diversion route arterials identified in the Incident Management Plan and the initiation of activities to obtain funding to develop the diversion timing plans as well as to expand and upgrade the City's traffic signal system. Another short term priority is enhanced institutional coordination, which will be necessary for a coordinated and comprehensive approach to transportation management and will also be a critical component for the success of future activities. Enhanced emergency management, including expanding the opticom signal preemption system and providing an interface with railroad crossings, and enhanced transit management, through the use of AVL technologies, are also short term priorities. An implementation schedule, which provides more detailed information about activities and projects to support short term priorities, is discussed later in this section.

Medium Term Priorities

Priorities for the medium term focus on expanding the framework that has been laid out in the short term, and addressing conditions that might be expected in the foreseeable future. Medium term priorities include expanding the geographic extent of the proposed traffic management system, broadening the scope of incident management activities to better address the special requirements posed by hazardous materials incidents and the areas sensitive to incidents, and expanding the kind of information provided to travelers in an effort to not only inform, but also to have a greater influence on traveler behavior.

Another medium term priority is to further integrate the freeway system with the arterial and transit systems in the metropolitan area. This implies additional coordination with the traffic signal system in Wichita for the upgrade to advanced or adaptive signal control on arterial routes that will be used for diversion from the freeway. This also implies the provision of transit information in addition to freeway information for trip planning purposes.

Long Term Priorities

Long term priorities generally address issues that are not currently critical problems, and may include taking a proactive approach to potential problems. Long term priorities include the expansion of the traffic management system to encompass the entire expressway system, implementation of technologies related to commercial vehicle applications, and the implementation of programs, technologies and facilities which would provide an alternative to the single occupancy vehicle. Dedicated transit facilities and advanced ride matching programs are just a couple of ways to encourage alternatives to the single occupancy vehicle.

Implementation Schedule

The primary focus of the implementation plan is a freeway management system. The secondary focus is on implementing the framework used to tie all activities together to form a traffic management system which includes the freeway, arterial and emergency management systems.

System components have been identified for a freeway management system that provide coverage of the entire metropolitan area. Implementation of the components is recommended to be staged over three (3) phases. Conceptual layouts for the placement of closed circuit television cameras (CCTV's), variable message signs (VMS's), highway advisory radio (HAR) transmitters and signs, and traffic detectors are shown in Figures 6-1, 6-2, 6-3 and 6-4, respectively. The locations identified in these figures are color coded to reflect the recommended staged implementation. Following a brief discussion of the basics of the freeway management system, each phase is addressed as it relates to implementation in the short, medium, and long term.

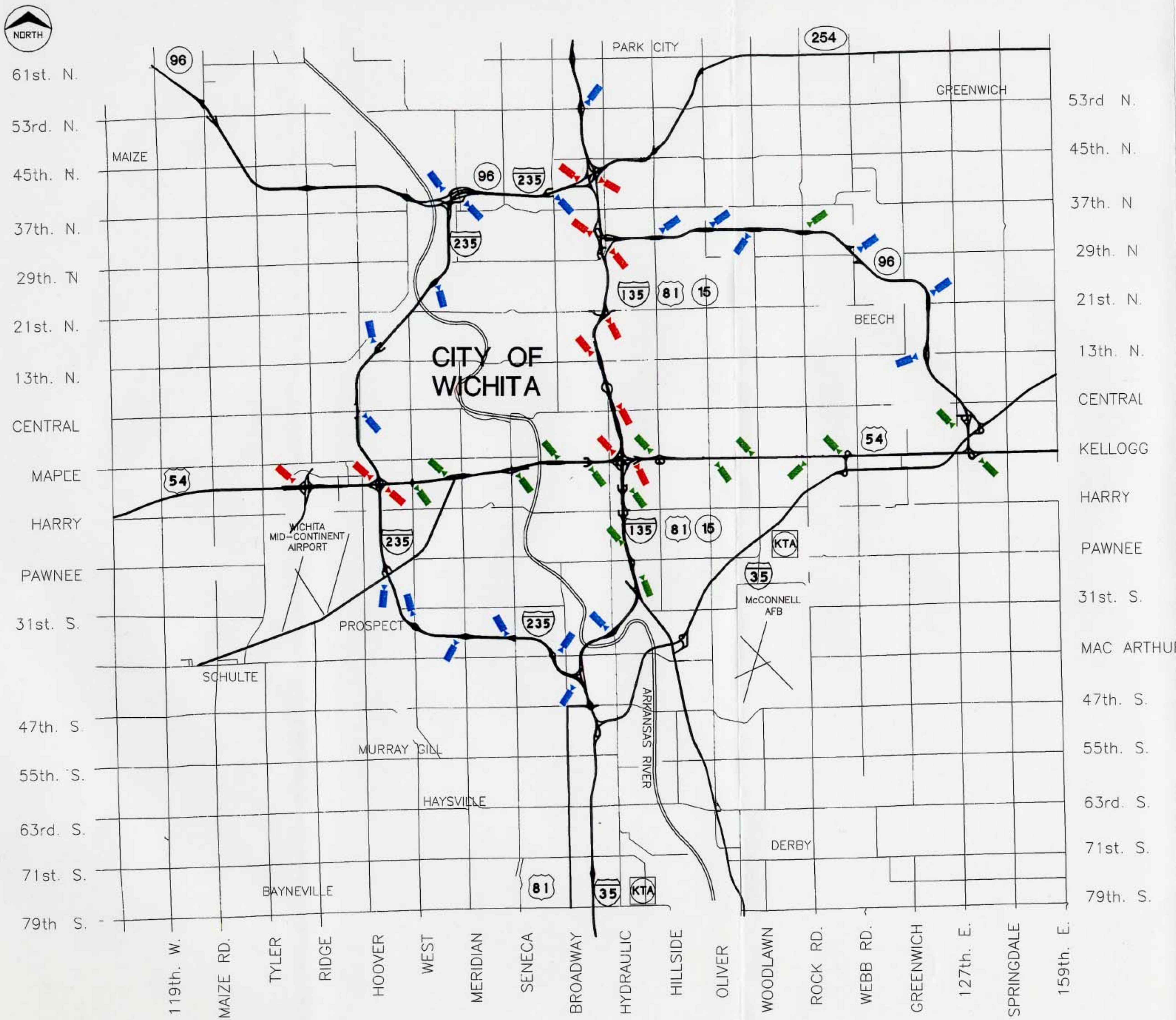
Freeway Management System

The proposed traffic management system and the related components address short term priorities by meeting the need for incident detection, verification, and response.

When the system is fully implemented, incident detection will be provided by detector station locations every half-mile. Computer algorithms will automatically process the data from these detectors, displaying real-time travel speeds, and providing notification of unusual traffic characteristics that might indicate an accident or other incident. Incident detection may also be provided or supplemented by other means, such as motorist assistance patrols (MAP) and cellular phone calls.

CCTV camera images will provide the incident verification. This visual verification will provide not only information about the nature of the accident and the kind of equipment needed, but it also will allow positive identification of incident location. Video image detection (VID), which consists of CCTV and computer algorithms that analyze the visual image to determine operating characteristics, may also provide incident detection capabilities and may be a viable alternative in the near future. While some systems currently use VID in conjunction with other means of detection, no system currently relies solely upon VID.

Incident response includes any action taken as a consequence of the situation on the freeway. This may include contacting emergency responders through 911 or the dispatch of MAP. Incident response may also include all resulting communications with motorists, such as messages on HAR and VMS's, and information provided to traffic reporting agencies.



WICHITA METROPOLITAN AREA
ITS EARLY DEPLOYMENT STUDY
STRATEGIC DEPLOYMENT PLAN

LEGEND

SHORT TERM
MEDIUM TERM
LONG TERM
CCTV CAMERA

FIGURE 6-1
CCTV IMPLEMENTATION

HNTB ARCHITECTS ENGINEERS PLANNERS
The HNTB Companies

T:\MSMCAD\28411-WICHITA\USER SERVICE FIGURES\FIGURE6_1.DWG 6/1/98

WICHITA METROPOLITAN AREA
ITS EARLY DEPLOYMENT STUDY
STRATEGIC DEPLOYMENT PLAN

LEGEND

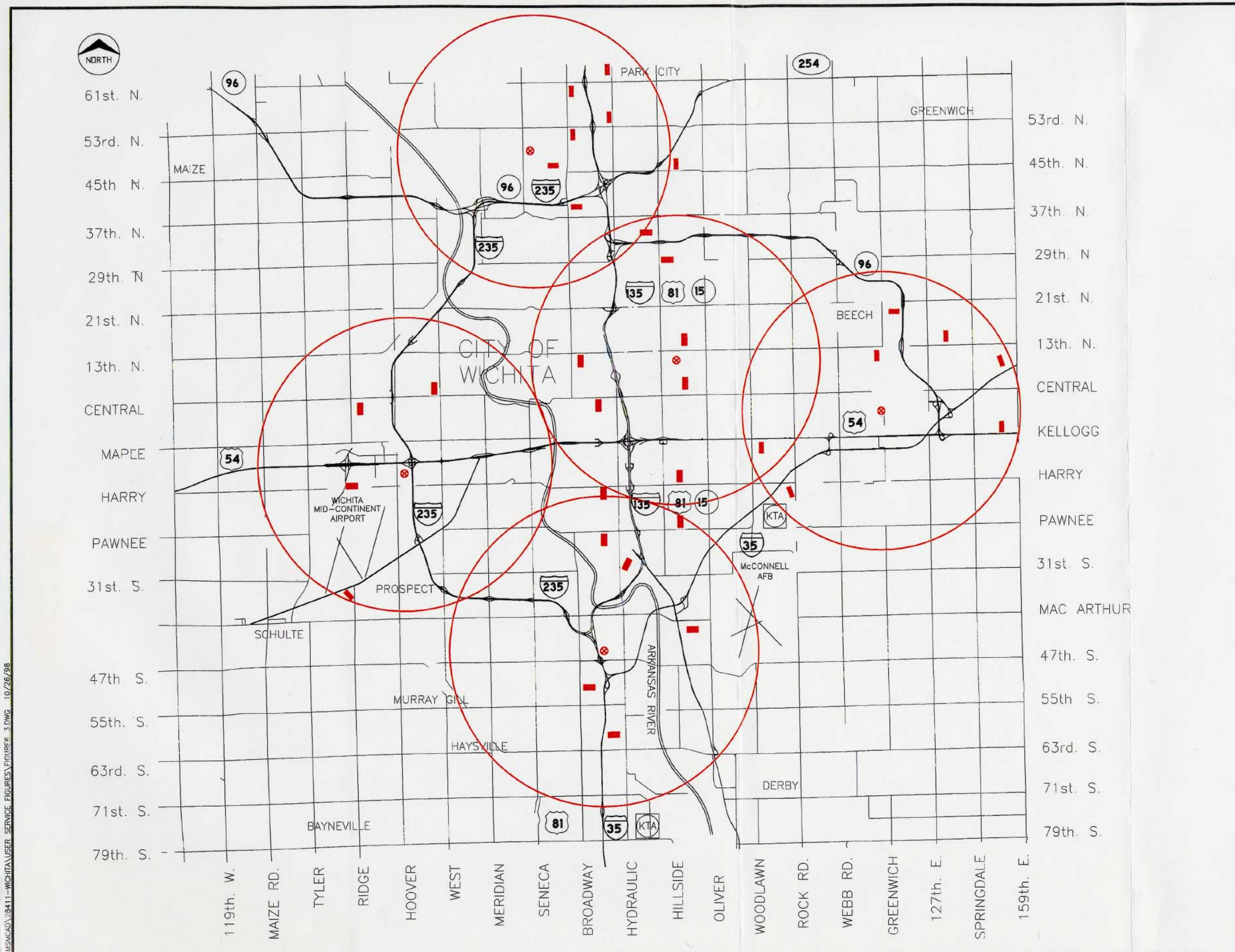
SHORT TERM
MEDIUM TERM
LONG TERM
VMS

FIGURE 6-2
VMS IMPLEMENTATION

HNTB ARCHITECTS ENGINEERS PLANNERS
The HNTB Companies

T:\MSMCAD\28411-WICHITA\USER SERVICE FIGURES\FIGURE6_2.DWG 10/26/98

WICHITA METROPOLITAN AREA
ITS EARLY DEPLOYMENT STUDY
STRATEGIC DEPLOYMENT PLAN

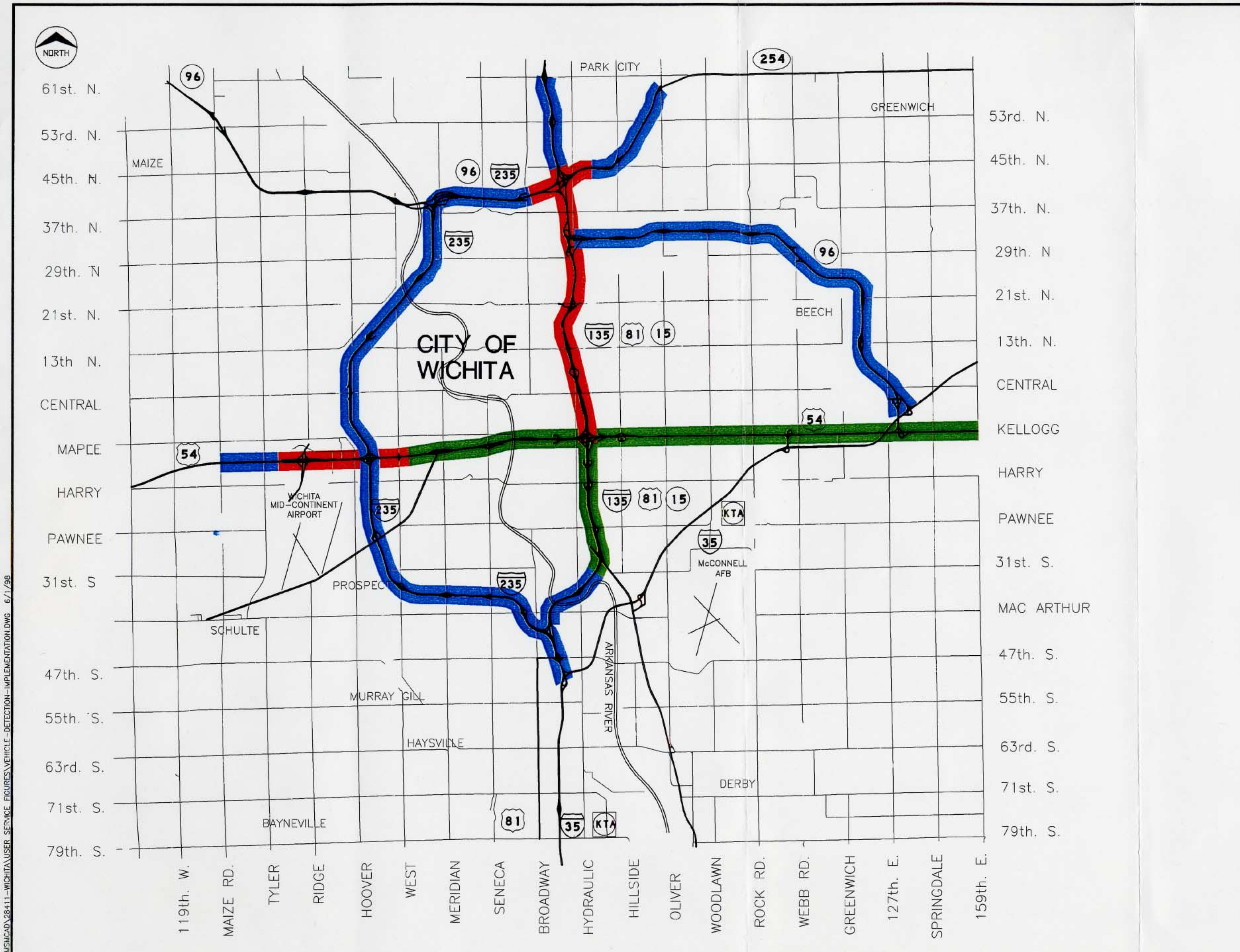


LEGEND

- SHORT TERM
- MEDIUM TERM
- LONG TERM
- HAR TRANSMITTER
- HAR SERVICE AREA
- HAR SIGN

FIGURE 6-3
HAR IMPLEMENTATION

HNTB ARCHITECTS ENGINEERS PLANNERS
The HNTB Companies



WICHITA METROPOLITAN AREA
ITS EARLY DEPLOYMENT STUDY
STRATEGIC DEPLOYMENT PLAN

LEGEND

- SHORT TERM
- MEDIUM TERM
- LONG TERM

FIGURE 6-4

VEHICLE DETECTION IMPLEMENTATION

HNTB ARCHITECTS ENGINEERS PLANNERS
The HNTB Companies

Short Term

Activities identified for implementation in the short term include all activities and projects to be implemented within five years. These also include a few "early winner" projects. These projects have met a number of criteria including relatively low cost, short development time, relatively high priority, and implementing the more accessible market packages. These projects also serve to enhance the public image of ITS, setting the stage for future projects.

The primary activity in the short term is the implementation of a freeway management system in the Wichita metropolitan area, mainly along I-135 through the center of Wichita. This facility carries high traffic volumes and has a high occurrence of accidents. Consequently, any breakdown in traffic flow due to an incident or construction can have significant impacts in terms of delay. Other short term activities include beginning the implementation of arterial and emergency management systems.

All activities recommended for the short term are described below:

- Permanent CCTV cameras, permanent VMS's, HAR transmitters and signs, and vehicle detection systems should be installed as shown in Figures 6-1, 6-2, 6-3 and 6-4. The TOC hardware (monitors and switching equipment) and software should be installed to accommodate the freeway coverage through the medium term plan.
- An Incident Management Plan encompassing the I-135 corridor and West Kellogg through the City of Wichita has been developed as part of this study. The Incident Management Plan provides recommendations for enhancing interagency coordination during a major incident as well as indicating preferred alternate routes for each roadway section blockage. If successfully implemented, the Incident Management Plan will result in improved response and clearance times, resolve some site management issues, and reduce the inconvenience and delay to the motorists through alternative routing. Using the initial plan as a model, the incident management committee should work to expand the plan to cover the entire freeway system in the Wichita area.
- Freeway milepost markers and signs on overpasses, indicating the cross street, are recommended for implementation on all freeway facilities in the Wichita area. Milepost markers are recommended for installation at 0.2 mile intervals on all freeway facilities. This signing contributes to the Emergency Notification and Personal Security and Incident Management user services since it provides a means for the accurate identification of incident location.
- The expansion of the motorist assistance patrol (MAP) to provide coverage of the Kellogg Expressway, in addition to the coverage of I-135 and I-235, during the peak hours is recommended. The coordination of MAP activities with other activities in terms of incident response and traffic control is strongly recommended. The sharing of information with traffic reporting agencies and any other entities that enhance communications with the public is also strongly recommended. MAP services contribute to the objectives of the Incident Management user service.
- There is a desire within the City DPW to expand the system to include all of the City owned signals. The increased coordination of the arterial signals would enhance the utility of arterials as alternate routes to the freeway and would contribute to the objectives of the Traffic Control

and Incident Management user services. Since it is outside of the scope of this study, it is recommended that the City conduct a feasibility study for upgrading and expanding the existing signal system.

- The City DPW and the City fire department have been satisfied with the performance of the signal preemption test project and would like to expand the system along the heavily traveled corridors in the City. This implementation will assist in getting the emergency responders to the incident scene in less time, thereby reducing clearance time and increasing public safety. This will contribute to the traffic control, emergency vehicle management and incident management user services.

- The implementation of an AVL system for emergency response vehicles in Sedgwick County is recommended. Initial implementation should include the police vehicles since they normally on the move during patrol times. This will provide accurate information describing the location of the vehicles, thus allowing dispatchers to send the first available vehicle within close proximity of the emergency location. This contributes to the emergency vehicle management user service.

- It is recommended that the railroad crossing gate status be transmitted to the Emergency Management Center. This would identify emergency routes blocked by trains or malfunctioning gates to the dispatchers so they in turn could notify the emergency vehicle en-route to alter their response route and would help identify malfunctioning gates. This will contribute to the emergency vehicle management and traffic control user service.

- A permanent traffic operations center (TOC) should be established for the metropolitan area. This center may be located in the new Emergency Communications (911) Center currently being studied by the City and Sedgwick County.

- If co-location is an acceptable alternative to all agencies, the planning and design of the new 911 center should include the future needs of the Traffic Operations Center. Once completed, this center will become the heart of the traffic management operations in Sedgwick County. Consideration should also be given to including the transit operations in the center in the future. Ideally the facility would be sized to be large enough to serve the entire metropolitan area. At the very least, the proposed facility should be constructed to accommodate the needs of the implementation of the Medium Term Plan.

- Weather information should be available at the TOC. If the TOC is co-located with the 911 Center (which currently receives such information), the weather data could easily be shared.

- Traffic conditions should be provided to traffic reporting agencies and to television and radio stations. The provision of traveler information directly to motorists via telephone and/or the Internet should also be explored. It may be possible to partner with a private entity for the provision of a highway advisory telephone service.

- The TOC should work with interested local public works departments and emergency responders to establish video feeds from the CCTV cameras, controlled by the TOC, to the local agencies and the emergency response centers.

- Activities conducted by the TOC that are related to incident management should be in accordance with the guidelines established in the Incident Management Plan for the Wichita area.

- Incident data should be compiled and examined to determine if there are any patterns with respect to hazardous material incidents. For example, whether hazardous material incidents are more prevalent at certain locations, such as near manufacturing plants, railway junctions or freeway sections with limited geometrics, and whether any particular kinds of hazardous material warrant greater tracking. If analysis indicates that some locations or types of hazardous material are disproportionately affected, appropriate action may be action. Such action may entail increased monitoring of "problem" sites, or increased tracking of "problem" substances. Activities related to hazardous material incident response and planning should be conducted with input from local hazardous material incident response agencies.

- Traffic signal timing plans appropriate for freeway diversion should be developed for the alternate routes that have signal control hardware to support implementation. The Wichita area currently has a central control system for most of the signals in and around Wichita, including those on diversion routes.

- Standards for construction and reconstruction projects should be developed to reflect the needs of an intelligent transportation system. These standards would accommodate future needs that could easily be accommodated during roadway and/or shoulder construction and reconstruction activities. Standards should include design considerations for interchanges to make provisions for conduit for power distribution and communication to ITS elements, as well as provisions for junction boxes. With respect to conduit for fiber optics, appropriate applications would include freeways and arterial diversion routes that do not have fiber optics, as well as connections from field equipment to the fiber optic backbone.

  Similarly, construction and reconstruction activities should consider the needs of emergency responders during incident management activities. For example, it is recommended that provisions for fire hoses be included in all noise walls that will be constructed or renovated in the metropolitan area. These holes should be located so that they correspond with fire hydrant locations, and should be marked clearly. These holes would allow fire fighters to easily access the fire hydrants, facilitating response to freeway incidents involving a potential fire hazard.

- KDOT should continue working for the most favorable placement of a fiber optics communications backbone on all major freeways in the Wichita area. KDOT has negotiated a resource sharing agreement with Digital Teleport Inc. that would provide a fiber optic communications network that would support the Wichita ITS implementation. For now, the agreement would provide a fiber optic ring around Wichita along the expressways.

- A policy regarding the provision of traveler information should be developed. This policy would initially address issues such as whether alternate routes should be provided to motorists, and should evolve to address related issues in the future, as needed. This policy should also address price issues, for example whether all information should be provided without charge, or whether some users should pay a price for specialized information. In the future, for example, it may be appropriate to charge private entities who request the information in a certain format and then provide the information to customers for a fee.

- A partnership with a private entity (discussed in the *Funding Issues* section) should be considered as an option for the provision of traveler information, especially in the short term. This kind of partnership would allow a system to be "up and running" in less than a year, and would not require that the City or KDOT dedicate staff or space to an interim traffic operations center.

- Efforts should be made to coordinate with planning agencies to assure that local and regional plans incorporate ITS concepts. Coordination activities should continue with the MAPD to assure that ITS projects are incorporated into the Transportation Improvement Plan. Coordination with local planning agencies should also be initiated to assure that they understand ITS and how local applications can work together with ITS applications in the Wichita area.

- With respect to the TOC, design activities for the proposed 911 Center should consider inclusion of a TOC to serve the entire Wichita metropolitan area. Thus, coordination will be required with the City and KDOT. Ideally the facility would be sized to be large enough to serve the entire metropolitan area. At the very least, the proposed facility should be constructed to accommodate the needs of the implementation of the Medium Term Plan.

Early Winners

The implementation of freeway reference markers and overpass signing and the expansion of motorist assistance patrols have been identified as "early winner" projects due to their low cost, short development time and high priority. It is recommended that these projects be implemented as soon as possible to begin enhancing the public image of ITS in the Wichita area.

Medium Term

One primary activity in the medium term is the expansion of the traffic management system. This would extend freeway management coverage on I-135 and would include most of Kellogg. It is assumed that the construction of the Kellogg expressway to the county line will be complete in this stage. Additional and more specific activities to be implemented in the medium term are as follows:

- CCTV cameras, permanent VMS's and vehicle detection stations should be installed as shown in Figures 6-1, 6-2, and 6-4. Additional CCTV cameras may be needed at interchanges for complete coverage.

- Efforts should be made to provide transit information, such as information on transit schedules, in conjunction with traffic information. This information may be provided via Internet or telephone, depending on the methods by which highway information is provided. The TOC does not need to be directly involved in the provision of this information, however, it will need to coordinate with the transit entities so that this information may be provided through the central information server and/or other means of information dissemination.

- Information sharing between the train control systems for Union Pacific and Burlington Northern Santa Fe and the TOC should be investigated. Linking train location information to emergency dispatcher systems would allow the dispatchers to identify the response routes that may be blocked by freight trains. The dispatchers could then reroute the response vehicles along roadways that are without obstruction.

- Technologies to facilitate commercial vehicle operations should be considered for implementation. Although many of these would be implemented by enforcement and administrative agencies, the TOC may benefit from interaction with commercial vehicle entities. In Minneapolis, the traffic management center currently provides information to commercial vehicles. These vehicles, in turn, serve as spotters by notifying the traffic management center of accidents or unusual travel conditions.

Long Term

One activity for implementation in the long term is complete coverage of the metropolitan area with a traffic management system. Extension of the freeway management system to all major freeways in the urban area would allow re-routing of through traffic around congested areas, and would allow traffic management on a system wide basis. However, relatively low volumes and accident rates on many of the Long Term Plan facilities imply a relatively low benefit-cost ratio (calculated in the next chapter) at the present time and in the near future. Eventually, however, growth in traffic volumes, as well as decreasing prices for technologies, would be expected to result in more favorable benefit-cost ratios. Additional and more specific activities to be implemented in the long term are as follows:

- CCTV cameras, permanent VMS's, and vehicle detection stations should be installed as shown in Figures 6-1, 6-2, and 6-4. Additional CCTV cameras may be needed at interchanges for complete coverage. The TOC hardware (monitors and switching equipment) and software should be expanded, as needed, to accommodate the additional freeway coverage.

  Benefit-cost ratios should be used to guide the priority of implementation for the long term plan. These ratios should be re-calculated in the future to reflect the actual volume changes, changes in accident rates, and changes in the price of equipment. Installation of equipment for freeway surveillance and verification on all facilities will result in complete coverage of the metropolitan area.

  Efforts should be made to coordinate the provision of information from the TOC with the provision of traveler services and other tourist information. This may include information kiosks at the airport, the zoo, Boeing, and/or other tourist/business centers. This may also include integrating current traffic information into computer "yellow page" system which direct tourists to locations they select. For example, travelers could obtain information about all local Chinese restaurants as well as current travel times to each restaurant. It would even be possible to allow tourists to make "real-time" dinner reservations, so the restaurant could know they are coming and have their table ready when they arrived.

- Efforts should be made to coordinate the provision of information from the TOC with the provision of in-vehicle information, including en-route driver information and route guidance information. Although the TOC may not directly interface with in-vehicle devices, they should coordinate with private or other entities to provide this information. Under this scenario, current travel speeds could be used to determine the route with the shortest travel time.

- Implementation of technologies to encourage alternatives to single occupancy vehicle (SOV) commuting should be considered for implementation. The provision of real-time carpool matching and flexible transit routing and scheduling are just two examples of possible activities. The provision of high occupancy vehicle facilities should also be considered. Although these activities may be primarily conducted by Wichita Transit and the MAPD, information about these activities should be available through the information server.

On-going

There are a number of activities that should be on-going in the short, medium and long term. These activities reflect the need for institutional coordination as well as system evaluation.

- It is recommended that the Steering Committee continue meeting on a regular basis after completion of this study. This will maintain the "momentum" gathered by the agencies involved to improve coordination and implement the recommendations stated in this report.

- It will be necessary for the TOC to coordinate with local public works agencies and emergency response entities. In the future, it may also be necessary for the TOC to coordinate with transit providers for the exchange of information.

- As local jurisdictions acquire more sophisticated equipment, the need for the exchange of information will increase. For example, the TOC may desire signal timing information for traffic signal controllers operated by the City on alternate route arterials.

- The TOC will need to coordinate with emergency responders on an on-going basis. As the emergency response agencies acquire automatic vehicle location (AVL) systems, the TOC may wish to use these systems as probes to indicate travel speeds, especially on segments of the system without detectors or surveillance equipment. Similarly, emergency responders may wish to use travel time information from the TOC to determine which vehicle and route should be used to respond to a call.

- The TOC still should coordinate with Wichita Transit. Wichita Transit's future AVL system may be used to provide information to the TOC about travel times and alternate routes. Furthermore, it would be logical to expect that the TOC's information server would be a point source for information on all modes in the greater Wichita area in the future. Thus, coordination will be even more important.

- The TOC must work with the City to develop signal timing plans and policies. These plans and policies must be evaluated and modified, as necessary and as the system is expanded and upgraded.

- Local agencies must notify the TOC of any construction or maintenance activities that would interfere with the use of an arterial as a diversion route.

- The detectors installed as part of the traffic management system should be used to gather information on "before" and "after" conditions. This information can be used for decision making for later study phases, to verify estimated benefits, and to increase the accuracy of projected benefit-cost ratios.

- Data gathered by the freeway surveillance system can be used to identify the location, severity and duration of recurring congestion. This detailed data can be used to assess the need for and project the effectiveness of strategies such as ramp metering.
- The impact of the provision of traveler information, including information about recurring congestion, incident related congestion, and alternate routes, may be evaluated using freeway data gathered by the freeway surveillance system.

Guide to Deployment

This is intended to be a guide for locating Intelligent Transportation System equipment along roadways in the Wichita metropolitan area. This section addresses a number of issues, including CCTV cameras, VMS's, HAR, detection equipment, diversion routes, and arterial traffic control systems.

With respect to equipment, currently available state-of-the-art technology should be employed whenever possible. However, value engineering should be used to determine the most cost effective equipment to be used. The cost of training, maintenance and operations are also important criteria that should be considered.

Closed Circuit Television Cameras (CCTV)

On freeways, CCTV cameras should be placed to allow complete coverage of the roadway. This may require spacing as frequent as one every mile. The stage implementation of the CCTV cameras is shown in Figure 6-1.

CCTV priority locations include high accident locations and interchanges with other freeways and with major arterial roadways. More than one CCTV camera may be needed at some interchanges. The CCTV cameras would be used to verify incidents and the conditions of interchanges to diversion routes before, during and after a diversion plan. In many cases, the capacity of the interchange will be unable to accept the additional traffic volume, especially at peak traffic times. The CCTV images could be used to determine whether diversions should be used and/or continued or discontinued. CCTV cameras located on arterials may be implemented and shared with cities, providing an opportunity for shared costs and benefits.

Variable Message Signs (VMS's)

The kind of VMS required and the recommended placement of the sign varies depending on the type of facility. Possible locations for VMS's for each phase are shown in Figure 6-2.

On freeways, VMS's should be placed prior to interchanges with other freeways or arterials for route diversion information. VMS's should be placed approximately three-fourths of a mile prior to the alternative route decision point, keeping in mind the sight distance necessary to read a three-panel message at the prevailing speed of the facility. Special attention should be given to vertical and horizontal curves.

In general, VMS's should not be located prior to interchanges with roadways that have little or no capacity to accept the diverted traffic.

Highway Advisory Radio (HAR)

It is recommended that a system of individual HAR transmitters be deployed to cover the entire metropolitan area. A conceptual layout of HAR coverage is provided in Figure 6-3 (approximate radius shown is 3 miles).

The transmission ranges should be set and the transmitters should be located such that the messages are received by those using the information. There are two approaches to accomplish this, the first and recommended approach is to use a single frequency for the entire metropolitan area. Under this scenario, drivers would be able to access information anywhere in the metropolitan area on the same frequency, minimizing confusion. A disadvantage of this is that there can be only one message for the whole network. A second approach is to use different frequencies for adjacent transmitters. This approach allows more complete coverage, but requires drivers to know where they are and know the associated frequency, changing the radio station as they enter a new HAR coverage area.

Traffic Detection Systems

Detection equipment should be deployed along the freeways. Detection equipment may also be deployed along segments of roadways that act as links between alternate routes. These detection systems would provide valuable information with regard to travel speeds and traffic volumes to determine the usefulness of a link for diversion purposes.

Detection Systems should be deployed on freeways at one-half mile intervals or between interchanges. Whenever possible, detection equipment should be employed that is non-intrusive to the flow of traffic. This provides detection equipment that can be installed, operated and maintained with minimal disruption to traffic flow.

On diversion routes that are major arterial roadways and that have at least two travel lanes per direction, detection systems could be used to evaluate the capability of the arterial to handle the additional capacity resulting from freeway diversion. Such systems may be appropriate for implementation in the future by cities or other agencies with jurisdiction, however such systems are not currently recommended.

Diversion Routes

Ideally, choices for traffic diversion routes should be prioritized as follows:

First: Freeway to Freeway
Second: Freeway to Major Arterial Roadway

The key to mitigating the impact of diverted traffic on any one roadway is to provide the information over as wide an area as possible to the motorists. This allows the motorist to choose the diversion route well in advance of the incident. Providing information to the motorist about the extent of the queue developed by the incident may help motorists decide whether to stay on their route to reach their destination.

If the alternate route has not been instrumented, then manual means of monitoring the alternate route should be deployed until the alternate route has been instrumented. This can be accomplished through roaming service patrols and cellular call-in by motorists to the TOC.

An analysis of the capacity of the available adjacent alternative roadways should be performed. A list of criteria which may eliminate a roadway from being an alternative route is as follows:

- Single lane in each direction.
- School located along the route.
- Hospital located along the route.
- No traffic signals to control or use to artificially increase capacity for diverted traffic.
- Limited overhead clearance for large vehicles.
- Limited turning radii for large vehicles.
- Substandard roadway alignment or geometrics.
- Lack of shoulders.
- Residential areas.
- Heavy pedestrian traffic.
- Active railroad crossings.
- Substantial change in speed limits.
- Circuitous routes.
- Roads which require resurfacing and/or reconstruction.

Possible diversion routes are included in the attachment to the *Wichita Area Incident Management Plan.*

Arterial Traffic Signal Systems

The traffic signal control system should be expanded to include all signalized arterials that may be used as alternate routes. These alternate routes should be designated mutually by the City or agency with jurisdiction and by KDOT. Key arterial diversion routes are shown in the Incident Management Plan for the Wichita Area. The City and KDOT should work together to determine an appropriate timing plan prior to an incident. These timing plans should then be evaluated and modified, as necessary.

It is also important that issues related to liability be addressed prior to implementation. Records of all changes in signal timing will need to be kept, and issues related to agency liability will need to be addressed thoroughly.

6.2 OPERATIONS PLAN

The key to success of the Wichita traffic management system will be an effective program of operations and maintenance. This will require personnel located at the TOC, personnel responsible for field maintenance, and a management structure to coordinate and administer the overall operation. Training of staff, both initially and on a continuing basis as new equipment and functions are added, is critical to ensure that the staff can provide maximum effectiveness. Complete and thorough system documentation is also necessary for effective operation. This section presents a review of actions and issues related to the operation and implementation of the future system. Procurement methods, staffing, TOC sizing, system start-up plan requirements, and operations plan requirements are also addressed.

Agreements and Memorandums of Understanding

In order to be effective, the proposed traffic management system must be conceived and operated in a cooperative effort by multiple agencies. Generally, its purpose is to be responsive to traffic and incident conditions without regard to jurisdictional boundaries. The system will be designed as a unit, but it must operate in the context of decentralized functions and responsibilities. Since it will support and enhance current functions, the cooperative relationships established for its operation will extend beyond its functions of incident detection, incident response, and motorist information. The system will serve as an effective catalyst to communication among agencies involved in incident response.

A series of agreements and memoranda of understanding will be necessary to establish and support the traffic management system. These will need to be developed over a period of time as an ordinary part of system design and development. Multiple agreements or memoranda are advisable in lieu of a single document to provide flexibility for responding to future needs.

Potential needs for cooperative agreements or memoranda of understanding would likely include four categories: agency support, system design; construction, operations, and maintenance; emergency response; and specialized control plans.

Agency Support

One of the first documents to be executed should be a joint statement of support for improved incident management systems and operations within the Wichita metropolitan area. This should be a statement of policy, with specific roles and responsibilities to be identified in follow-up documents. The agency support statement should be signed by the involved state, county and city authorities. This document will serve to inform the public of intent and commitment to the system, and will provide general guidance (through goals, objectives, and policies) for further system development.

To best serve its intended purpose, execution of the agency support agreement should be well publicized. This could include signing ceremonies by county, city and state officials and may include media coverage. In addition to indicating support and cooperation of involved jurisdictions, this will provide an early opportunity for public education regarding the character and intent of the system.

System Design, Construction, Operations, and Maintenance

Agreements will be necessary among participating jurisdictions and agencies to establish and operate the system. These will address the following categories: funding, system operation and maintenance, and functional roles and responsibilities. Among the topics which may need to be addressed for each category are the following:

- *Funding*
  - Engineering
  - Construction
  - Start-up
  - Operations
  - Maintenance
- *System Operation and Maintenance*
  - Traffic operations center
  - Field equipment
  - Administration and management

Staffing

- *Functional Roles and Responsibilities*
  Communication responsibilities of traffic operations center
  On site coordination (incident manager, call for tow trucks, etc.)
  Roles and limitations of service patrols
  Identification and management of diversion route systems
  Operation of variable message signs and motorist information systems
  Data links (CCTV, traffic counts, operating speeds, etc.)

Emergency Response

Agreements, legislation, and cooperative understandings should be developed for the coordination of incident response. Activities toward this end are currently underway with the creation of the Incident Management Task Force and the publishing of the Incident Management Plan for the Wichita area. Changes may be needed as emergency response personnel interact within the TOC and as the system design evolves, but, the system will not supplant or modify most established relationships.

Some potential new emergency response policies may require enabling legislation, including:

- Vehicle removal policies
- Lane closure policies
- Tow truck notification policies

Specialized Control Plans

In addition to agreements and/or memoranda of understanding for day-to-day system operations and emergency response, it may be useful to establish roles, responsibilities, and relationships for special conditions. These include the following, as a minimum:

- Recurring special events, such as the River Festival
- Unique special events
- Maintenance of traffic during construction
- Special incidents, such as hazardous material spills

Hours of Operation

Although some municipalities have provided for 24 hour weekday operation, it is possible to initiate surveillance on a more limited basis. Experience from other traffic management systems indicates that, at a minimum, the TOC needs to be staffed from the beginning of the morning rush hour to the end of the evening rush hour. One alternative would be 13 hour (generally 6:00 am to 7:00 p.m.) operation. Weekend staffing may not occur initially. However, it eventually may be needed, especially during special events or adverse weather.

Two different strategies for providing staff have been utilized by different agencies: utilizing agency personnel (either existing or new hires), and contracting to a private organization to provide the personnel. In either case, the budgetary impact is essentially identical, although the specific budgetary categories may be different. As such, there is no distinction as to which approach is used.

During mid-day hours, when traffic is lighter, the operational staff can utilize some of their time to perform other activities that can be handled from within the control room. But the operator is still required to be immediately available to monitor and coordinate response to an incident which may occur.

One major advantage to locating the TOC in the proposed 911 Center is that it will be monitored 24 hours a day by the 911 dispatch staff. However, if a major incident occurs during non-peak hours, the regular staff should be called in as necessary.

TOC Operators

The specific functions that the operator needs to perform include:

- Utilizing the computer displays and CCTV screens to monitor and verify the traffic conditions and incidents on the freeways.
- Operating the computer systems to select different displays and to control field devices, such as VMS's and CCTV cameras.
- Responding, via remote computer, to status and alarm messages generated when incidents are detected or equipment malfunctions are detected.
- Utilizing telephone and radio equipment to communicate with police, fire, and other personnel responding to an incident.
- Utilizing telephone or FAX equipment to communicate with media and the public regarding the status of an incident or current traffic conditions. This function may also be automated through the central information server, and/or through the provision of information via highway advisory telephone or the internet.
- Operating recording equipment, such as a VCR, that would be utilized to capture the specifics of a particular incident.
- Troubleshooting and performing simple replacements for malfunctioning equipment in the TOC.
- Maintaining logs and other required records of activities.

Several different strategies, alternatives to the more traditional full-time agency technical or support staff, have been utilized by other TOC's for hiring operators. These include hiring college students working part-time and hiring disabled individuals on either a part-time or full-time basis. If additional operators are needed during the peak periods, part-time employment may be a logical option.

It is estimated that the TOC will require one (1) manager and two (2) operators for the Short and Medium Term. The TOC will need the addition of an assistant manager for the Long Term. Ultimately, it is estimated that there will be one (1) manager, one (1) assistant manger, one (1) traffic signal system operator, and three (3) Incident Management/Traffic Management System operators.

Equipment Maintenance

The maintenance and repair of all equipment must be accomplished in a timely fashion in order to achieve effective system operation. The typical goal for these systems is a four hour response time from the time a failure is reported until the equipment is returned to service. This requires a maintenance technician with adequate spares, appropriate tools and equipment, and up-to-date training.

It is estimated that the system will need three (3) maintenance personnel for the Short and Medium Term, and one (1) additional person for the Long Term Plan (4 total for all phases).

It is recommended that at least one technician be dedicated to ITS equipment. While it is possible to share this individual with other maintenance and support activities, it is important that the technician's first priority be the support of the field equipment. This individual should be available prior to the start of any construction for the project to allow familiarity with the system design. The technician's input to the design process, to ensure that maintainability is built into the system, will yield long-term benefits. The technician should serve as the field inspector during all construction work so that details are retained by an agency employee. Also, since the technician will have to live with or correct any problems created by the construction, there will be a strong incentive to get the system built correctly.

Another important role of the maintenance technician is to coordinate with other roadway maintenance or construction activities to minimize the disruption of field equipment, since contractors and other organizations do not always recognize the importance of the field equipment and associated power and communications circuits. The maintenance technician, by being available or on-site during these potential disruptions, can minimize or eliminate equipment down-time.

The maintenance technician needs to be well experienced in a wide range of skills, including electronics, communications, power distribution, cable installation and repair, portable generators, and general small scale mechanical repairs. Since the maintenance technician will be faced with diverse equipment and failure conditions, a broad set of general repair capabilities is required. Effective troubleshooting and problem isolation techniques, supported by a systematic and logical approach, is needed to quickly identify and correct problems. Preventive maintenance, locating and repairing small problems before they become major, and conscientious record keeping and documentation are also regular components of the equipment maintenance program.

System Management

A manager of the operators and maintenance technician will be required. It is desirable that this individual also have an engineering background so that broader system support and long-range upgrades can be handled. The role of the manager is to provide day-to-day supervision and scheduling of operations and maintenance activities, to coordinate with other agencies and organizations, to develop plans and policies for incident management and freeway monitoring, and to financially manage the operation by developing budgets and being responsible for operating within these budgets.

The manager will also be available to support the operator during a major incident, to be a higher level liaison with other agencies and the media, and to supervise a back-up person if regular operations personnel are not available. The manager will be responsible for training new operations personnel, and ensuring that current staff are trained on new equipment and that refresher training is conducted for all personnel, as necessary.

The manager will be responsible for supervision of maintenance activities, ensuring that adequate spares are available and that the maintenance technician has all the tools, equipment, and test devices needed to perform effectively. The manager must make certain that the technician's training is current and up-to-date. When a crises occurs, the manager must expedite support and repair services, and provide a buffer between the maintenance technician and other individuals, so that the technician can work without being disturbed. As the system evolves into the full system, an Assistant System Manager will be required to support the management and operation of the TOC. The Assistant System Manager should have similar qualifications to the System Manager. The Assistant may work the shift opposite the System Manager to provide management of the TOC while the System Manager is not present

Support staff, such as secretarial, clerical and receptionist personnel, can be provided on a shared basis from the existing organization where the TOC will be located. The traffic management system and TOC do not require dedicated secretarial personnel. A part-time equivalent should be included in the budget to account for this labor component.

Implementation Plan

Part 655.409 of Title 23 Code of Federal Regulations requires the development of an Implementation Plan prior to the deployment of surveillance and control elements of an incident management plan. According to current guidelines, the Implementation Plan is to be completed prior to project design completion and must be approved by the Federal Highway Administration (FHWA) prior to authorization of construction funding. The Implementation Plan will need to finalize needed legislation, system design, procurement methods, construction management procedures, acceptance testing, and system start-up. It will also need to include an Operations Plan and Maintenance Plan which provides specific information regarding the equipment to be installed. The intent of the Operations Plan is to clearly describe all significant system features and the means for installing and operating the system. An important element of the Operations Plan is the commitment of involved agencies to staff the system and fund its operation. Many of these issues must await design activities in order to provide an appropriate level of detail.

Traffic Operations Center Concept

The TOC will serve as the centerpiece of the Wichita traffic management system. Most ITS functions will be performed at the TOC. Both technically and visually, the TOC will play a major role in defining the success and public image of the Wichita system.

The internal functions of the TOC will include items such as incident management, systems operations, freeway and arterial monitoring, congestion management, and other ITS activities. Important to the success of the internal operations of the TOC are the facilities (the building, grounds, utilities, etc.) and the location. Adequate floor space, highway access, communication linkage, site security, building construction, and alternate route access all contribute to a successful TOC.

Although the proposed 911 Center has been identified as a possible final location for the TOC for the entire metropolitan area, it is worthwhile to iterate the factors that should be considered when locating a TOC. If, for any reason, the City needs to find another location for the TOC, potential sites should be evaluated with respect to these factors.

- *Ownership* - Ownership of the property is an important factor. Whether the property is owned or leased has significant implications in terms of on-going expenses (such as rent) and stability, which would be affected by the lease term.
- *Space Availability* - Space availability refers to the amount of space available for the TOC. This is given in square feet for existing structures, and acreage for vacant lots.
- *Highway Access*- Highway access indicates distance to the nearest access to the highway system, such as I-135 or Kellogg.
- *Alternate Access for Emergencies* - Alternate access lists alternate routes from the site to the highway system. These routes are in addition to those listed in the highway access category.
- *Costs* - Costs include all items necessary to prepare the site for the installation of the TOC. Included within this would be items such as building construction or renovation, utility connections/installations, communication links, property acquisition, site preparation, etc.
- *Communication Link Potential* - This category reflects proximity to fiber optic networks, microwave towers, telephone lines, as well as types of telephone lines, cellular phone usage, short range microwave capabilities, etc. Proximity to the expressways is especially important when one considers the need to connect to the fiber optics communication infrastructure.
- *Site Utilities* - Site utilities include existence or availability of utilities such as electricity, sewer, HVAC, gas, and water.
- *Site Security* - Site Security includes items such as fences, barriers and adjacent types of development.

However, if the TOC will be housed within the new 911 center, space should be provided to accommodate the system components. The control room will house the operators at workstations, video monitors for the CCTV system, electronic system components, switchers, controllers, etc. The control room may also include a video wall that may be used for both graphics displays and viewing CCTV images.

6.3 INTERAGENCY COORDINATION

Agency Roles And Responsibilities

The following is a description of the future roles and responsibilities of the agencies participating in establishing a traffic management system for the Wichita area:

Kansas Department of Transportation

KDOT will oversee the development and operation of the TOC which will be the focal point for the traffic management system and the distribution of current traffic information. This system will eventually serve the entire expressway network and selected arterial facilities in the Wichita metropolitan area, and will consist of the following:

- Control of all field equipment on the freeways in the system.

- Equipment, primarily covering the freeway network, includes a VMS system, a traffic detection system, a CCTV surveillance system, and a HAR system.
- A traveler information kiosk system in key generators in the area and highway advisory telephone (HAT).
- An internet webpage for access by citizens and businesses in the area.
- Other future systems, not justified by existing traffic conditions, may include a freeway ramp metering system and freeway high occupancy vehicle (HOV) facilities. The need for these facilities should be continually evaluated over time.
- A direct connection should be provided between the TOC and the City of Wichita traffic signal system. This would allow for the exchange of traffic data and system status information between the two systems. Consideration may be given to allowing the 911 dispatchers to implement emergency diversion route timing plans during hours that the City traffic signal operator is not present. Agreements and memorandums of understanding would have to be established describing the conditions under which control would be warranted and permitted.
- The activities of motorist assistance patrols should be coordinated with the TOC to help in the removal of disabled vehicles associated with minor incidents and disabled vehicles.

The previously mentioned systems should be operated and maintained by KDOT, either directly through increased staffing and training for employees, or through a contract with an outside company or agency for the provision of the needed services.

Local Jurisdictions/Public Works Departments

Each arterial used for a freeway diversion plan should have a signal control system capable of adapting to accommodate the additional demand that would be expected. The City currently has a system that allows remote control for the implementation of a variety of pre-determined timing plans, including those appropriate for the implementation of a freeway diversion scheme. An alternative would be the use of adaptive signal control systems, which would automatically detect the increase in demand on the diversion route, and increase capacity as needed. Coordination with the TOC will depend on the method by which signal timing plans are changed, as well as the agreements between the TOC and the City. Ideally, coordination and communication would consist of the following factors.

- Although the City of Wichita will maintain primary control of operations of the signal systems, timing plans to absorb the additional demand resulting from freeway diversion will be implemented by the City upon the recommendation of the TOC, by the TOC during off-hours, or automatically implemented via adaptive signal control.
- Local jurisdictions will have access to current traffic conditions, including CCTV and additional data as needed, on the freeway facilities in their jurisdiction. Local jurisdictions will be responsible for obtaining the funding and equipment necessary to access this information.
- KDOT should retain primary control of the CCTV cameras on the freeways. Communications can be established for local agencies to view the CCTV camera images of

facilities in their jurisdiction at any time. Local agencies should be able to request selection and movement of the CCTV cameras in their area. Requests should be granted by operators at the TOC when possible. It may also be possible to implement CCTV cameras that could be controlled from multiple locations (by local agencies and the TOC). Under this scenario, the TOC would have primary control, and the TOC commands would override the local commands.

- If any CCTV's are installed along arterial streets in the future, they will be controlled by the agency responsible for implementing and operating such cameras, although the images should be available to both local agencies and the TOC.

Law Enforcement

The state and local police should coordinate and communicate with the TOC when responding to incidents on the freeway system. This includes not only response by law enforcement officers, but also the response of the Motorist Assistance Patrol.

- Local and state police should have access to CCTV camera images in their jurisdiction and should be able to request selection and movement of the CCTV cameras. The police should be able to view the freeway and arterial traffic status information displays. Law enforcement agencies will be responsible for obtaining the funding and equipment necessary to access this information.
- The TOC will communicate with law enforcement by either telephone or two-way radio.

Public Transportation

Wichita Transit should coordinate and communicate on an as-needed basis with the TOC.

- Wichita Transit should be able to access current traffic information and any other information that would be valuable for their operations. Wichita Transit will be responsible for obtaining the funding and equipment necessary to access this information. Transit agencies may use this information to re-route transit vehicles around congested areas.
- Wichita Transit's automatic vehicle location (AVL) system information should be made available to the TOC. The agencies operating the TOC will be responsible for obtaining the funding and equipment necessary to access this information.
- Any freeway HOV facilities developed in the future should be developed in coordination with Wichita Transit, as well as arterial HOV facilities.

Emergency Response and Coordination

The TOC should utilize the existing 911 system for direct contact with emergency responders in the case of an accident on the freeway. The system should be set up so that the TOC operator will be automatically connected with the appropriate agency upon identification of the location of the incident and the kind of emergency response agency needed.

- The existing 911 system will be maintained as the primary mechanism for responding to emergencies on the freeways.

- The TOC should use two-way radio for communication with emergency responders for on-going coordination once the incident response has been initiated.
- A special number for reporting non-emergency incidents on the freeway may need to be implemented as the system grows. This number would be answered by personnel at the TOC, who could then coordinate with the Motorist Assistance Patrol, or other appropriate agencies, as needed. Implementation of a system such as this one, which requires motorists to make a determination as to the severity of the incident (for example, vehicle disablement versus injury accident) would require significant public education activities.

Private Sector Involvement

Wherever possible, the private sector should be involved in developing and expanding the advanced traffic management system and the distribution of traveler information.

- The private sector should include, but should not be limited to, universities and colleges, manufacturing and service companies, the broadcast and print media, and communications and entertainment companies.
- Other opportunities for private sector participation might include information kiosks, new products testing, and the development of an area wide communications network.
- Information from the TOC should be available to traffic reporting agencies and cellular phone companies.
- Opportunities for public/private ventures should continue to be explored. Additional aspects related to public/private activities for the provision of traveler information are discussed later in *Funding Issues.*

6.4 IMPLEMENTATION ISSUES

Maintenance Issues

Agencies participating in the traffic management system should develop clear guidelines on the maintenance of the elements of the system. The following are conceptual maintenance assignments:

- KDOT should be responsible for the maintenance of the field equipment on their roadways.
- Local agencies should be responsible for maintenance of equipment they have purchased for communications and for obtaining information from the TOC.
- CCTV cameras and detection placed by the TOC on arterial streets that are primary diversion routes should be maintained by the TOC unless other agreements are made with the local jurisdictions.
- Space at the TOC should be reserved for maintaining, testing and troubleshooting. This space can be either on-site or off-site.

Operations Issues

Agencies participating in the traffic management system should develop clear guidelines on the operation of the system. These responsibilities should evolve from the following initial principles of operation including:

- Compatibility with TOC software and operations should be considered during selection of new signal system equipment on arterials that may be used as freeway diversion routes.
- An agreement between KDOT and the City of Wichita for the operation of signal systems and other equipment on arterial facilities needs to be developed. All operating agreements should be formalized and written, whether the work is done in-house at public agencies or by contract with private firms.

Open Issues

There are several issues that will need to be continually explored as new information becomes available and as technology and circumstances change. These issues include

- Roles for the private sector.
- Funding sources, which vary depending on the kind of expenditure, the agency requesting funds, and changes in legislation and available funding.
- Level of implementation, which will affect the number and variety of affected agencies.
- "Open architecture" should be a significant consideration with respect to integration with future ITS systems, such as in-vehicle navigation systems.
- The need to modify the system to incorporate new technologies.

6.5 FUNDING ISSUES

ITS projects are of such diverse scope that many unique combinations of existing Federal, state, local, and private financing opportunities are available to help build and operate these systems. The following sections highlight a number of specific and proven public and private sources that can be utilized as part of a creative financing package for ITS implementation and operation. This includes actual dollars such as public funding via the Transportation Equity Act for the 21st Century of 1998; the National Highway System Designation Act of 1995; various state and local user-fee options; in-kind services, such as trading of a portion of agency-controlled right-of-way to a communication company that wishes to install fiber-optic cables in exchange for that agency's right to use a pre-defined amount of fiber-optic bandwidth for either no fee or a significantly reduced fee; and innovative techniques for financing operating costs, such as the ability of an agency to sell their raw traffic information to value-added service providers who specialize in converting this raw data into valuable information for later re-selling to the public by the value-added service provider.

Federal Sources[1]

The Transportation Equity Act for the 21st Century was passed by Congress and was signed by President Clinton on June 9, 1998. Current calculations put the new law's funding totals at $217.5

[1] Adapted from material provided by ITS America

billion over six years (fiscal years 1998 to 2003). By comparison, ISTEA authorized some $155 billion over six years. TEA 21 achieves a 90.5% return to each state on receipts into the Highway Trust Fund. Average annual spending will reach just under $26 billion across all programs.

Of the $217.5 billion total, some $198 billion is "guaranteed" for highway and transit spending. That is, receipts from the federal gas tax into the Highway Trust Fund are guaranteed to be spent only on transportation. No longer will the amounts collected in the trust fund be available to offset other parts of the federal budget. Within the guaranteed spending category, highways will receive some $157 billion, transit roughly $36 billion, another $4.4 billion to highway programs not subject to annual obligation ceilings, and over $2 billion for highway safety programs. Additional authorizations for the highway and transit programs reach the total of $217.5 billion but are subject to the annual appropriations process.

TEA 21 also reauthorized the federal ITS program. The bill provides overall funding for the ITS program of $1.28 billion from 1998 to 2003. As proposed by FHWA and ITS America, TEA 21 allocates spending across two broad categories: (1) ITS standards, research, and operational tests funded at $95 million to $110 million annually; and (2) ITS deployment funded at $101 million to $122 million per year. Throughout TEA 21, there are also some 40 special ITS-related earmarks totaling between $210 million and $275 million over the six years of the bill.

One of the changes brought about by TEA-21 was to "mainstream" the ITS program into the traditional federal-aid highway categories. These changes clarify the regulations established by ISTEA. While the available funding pool has grown significantly, ITS projects and the government entities and companies behind them must now compete for this new funding with more traditional transportation programs, projects and players. The intent of these and other changes is to make ITS an "everyday" tool for state and local transportation authorities that can be supported by a variety of funding mechanisms.

What follows is a description of the several programs and provisions that, because of changes found in TEA 21, increase the available funding for ITS separate and in addition to the discrete federal program administered by the Federal Highway Administration. This summary takes into account the technical corrections bill, "TEA 21 Restoration Act" (H.R. 3978).

Title I Federal-Aid Highways

-- **Section 1106 Federal-Aid Systems.** TEA 21 makes a change to the list of eligible projects for National Highway System, or NHS, funding. The NHS program is one of the four block-grant programs through which the states receive Highway Trust Fund revenues based on a complicated formula. TEA 21 provides over $28.5 billion to the states under the NHS program. In section 1106 of TEA 21, "infrastructure-based intelligent system capital improvements" are added as eligible projects for NHS funding (new item O to 23 USC section 103(b)(6)). It should also be noted that TEA 21 continues from ISTEA as eligible projects under NHS "capital and operating costs for traffic monitoring, management, and control facilities and programs" (new item H of section 103(b)(6).)

-- **Section 1108 Surface Transportation Program.** This program, commonly known as STP, is the largest of the four large highway programs of Highway Trust Fund revenues. Overall, TEA 21 provides $33 billion that may be used by states and local governments for projects on any federal-aid highway. TEA 21 changes current law -- new item 13 to 23 USC section 133(b) -- to include "infrastructure-based intelligent transportation system capital improvements" as eligible projects.

As under NHS, TEA 21 continues the funding eligibility under STP of "capital and operating costs for traffic monitoring, management, and control facilities and programs" from ISTEA (23 USC section 133(b)(8)).

-- **Section 1110 Congestion Mitigation and Air Quality Improvement Program.** Otherwise known as CMAQ, this program will receive a 35% boost in funding over ISTEA levels to a total just over $8 billion in TEA 21. Under the National Highway System Designation Act of 1995 (P.L. 104-59), the CMAQ program was amended to include as eligible projects the establishment or operation of a traffic monitoring, management, and control facility or program if the facility or program would improve air quality (23 USC section 149(b)(4)).

In addition, a new provision was included in TEA 21 whereby ITS-related projects may be eligible for CMAQ funding if the program or project improves traffic flow, including projects to improve signalization, construct high occupancy vehicle lanes, improve intersections, and implement intelligent transportation system strategies and such other projects that are eligible for assistance under [the CMAQ program] on the day before the date of enactment of this paragraph. (TEA 21, section 1110(b)(6).). That is, the ITS-related project described above must have otherwise qualified for CMAQ funding any time prior to TEA 21 becoming law in order to receive such funding.

-- **Definitions under Federal-Aid Highway Programs (Section 1201).** TEA 21 did not change the definition of "operational improvement" under the federal-aid highway capital programs, as had been proposed, to include the operation or maintenance of certain ITS systems, such as for communications systems, roadway weather information and prediction systems, and the like. As passed in ISTEA, the definition of "operational improvement" already included costs associated with capital improvements to install -- but not operate or maintain -- traffic surveillance and control equipment, computerized signal systems, motorist information systems, etc. US DOT and ITS America had advocated the expanded definition of "operational improvement" for TEA 21, but it was not included in the final bill. (Section 1201(a)(18) retains the definition from ISTEA.)

However, under section 1201 a new term and definition was added for "operating costs for traffic monitoring, management, and control." In section 1201(a)(17), this term is defined as: including labor costs, administrative costs, costs of utilities and rent, and other costs associated with the continuous operation of traffic control, such as integrated traffic control systems, incident management programs, and traffic control centers. How the inclusion of this new definition will affect the availability of new funding for ITS-related operating costs remains to be seen.

-- **Sections 1118 and 1119 National Corridor Planning and Development Program and Coordinated Border Infrastructure Program.** These two programs are new in TEA 21. In response to NAFTA, Congress established the National Corridors Program to help plan, design and construct economic and trade corridors of national significance in order to improve the flow of commercial traffic. The I-35 corridor is included in this program. Similarly, the Border Infrastructure Program is designed to improve the flow of people and goods across international borders.

Both programs are discretionary to the Federal Highway Administration with funding totaling together $700 million over six years. Although only the Border Crossing Program specifically includes ITS applications as eligible for funding, ITS-related technologies will figure prominently in both programs. Subsection 1119(b)(3) for the Border Crossing Program includes as eligible for funding: "operational improvements, including improvements to electronic data interchange and use of telecommunications, to expedite cross border vehicle and cargo movement."

-- **Subtitle E Finance (sections 1501 - 1504).** TEA 21 establishes a new innovative finance program called the "Transportation Infrastructure Finance and Innovation Act of 1998" (or TIFIA) that permits the Department of Transportation to provide financial assistance to projects in the form of direct loans, loan guarantees and lines of credit. Almost all types of transportation projects are eligible for TIFIA assistance if the project size is at least $100 million (or 50% of a state's annual apportionment of federal-aid funds). In addition, a project must have the potential to be self-supporting from user fees or other non-federal funding sources. In total, some $530 million is provided in contract authority for TIFIA.

Included in TIFIA is a provision lowering the minimum project size from $100 million to $30 million for ITS-related projects. (Subsection 182(a)(3)(B) of TIFIA) As the Conference Committee wrote, the rationale for reducing the minimum cost stems from the "substantial capacity enhancements attainable [from ITS] with but a limited investment."

Title III Federal Transit Administration Programs

Overall, transit programs will receive under TEA 21 some $41 billion in federal funding, of which approximately $36 billion is "guaranteed" funding behind the budgetary "firewall" created by Congress in this bill. Under section 3003, the definition of "capital project" is amended to include "transit-related intelligent transportation systems" (amending current 49 USC section 5301(a)(1)(A)).

This change in definition will make it possible for transit agencies and authorities to use formula and other block grant funding from the Federal Transit Administration, for the wide variety of ITS-related capital expenditures: e.g., purchases of buses equipped with ITS-related equipment, purchases of computers and software, engineering and construction, system integration, and the like. More specifically, ITS capital-related costs will be eligible under the transit formula funding program to all urbanized areas and certain rural areas (some $2.8 billion to $3.8 billion annually). Moreover, so-called "Section Three" programs for new rail starts, rail modernization and discretionary bus programs (some $2.2 billion to $3 billion annually) will now be able to fund ITS-related capital costs.

There is still the outstanding question of whether ITS-related operating and maintenance costs will be eligible for funding under TEA 21. Traditionally, the federal transit program covers operating and maintenance costs only for urban areas of less than 200,000 people; larger urban areas receive no federal funding for these expenses. TEA 21 did not clarify whether operating and maintenance costs, called "preventive maintenance" in the transit title, will now include these costs associated with ITS projects. Federal Transit Administration clarification is expected soon.

Other Provisions

National Architecture and Standards (5206) Like its predecessor, TEA 21 continues the emphasis on the development of the national architecture and standards for ITS applications. Funding for this activity comes from the general research money. TEA 21 offers three general provisions: (1) US DOT is directed to "develop, implement and maintain" a national architecture and standards for ITS; (2) the national architecture shall promote ITS interoperability and efficiency; and (3) standards-setting organizations may be used as appropriate.

More significantly, however, TEA 21 requires additional actions by US DOT to identify critical standards and then ties federal funding for ITS projects to adherence to those standards. First, by June 1, 1999, US DOT is to submit a report to Congress that identifies and gives the status of standards that are "critical to ensuring national interoperability" or the development of other standards. Second, US DOT is empowered to establish "provisional" standards if, by January 1, 2001, any such critical standards are not adopted and published by the appropriate standards development organizations. On this latter point, US DOT must first assess whether the development of critical standard or standards "jeopardizes the timely achievement" of the general goals of establishing a national architecture and standards for ITS. Upon such a finding, US DOT is required to establish a provisional standard or standards. US DOT can waive the provisional standards requirement under certain conditions.

TEA 21 goes on to require that all federal funds -- that is, all funds from the Highway Trust Fund under any program -- for ITS projects must conform to the national architecture and all standards or provisional standards developed under the ITS subtitle. Again, US DOT may waive this requirement under certain conditions for research programs and ITS legacy systems.

Last, TEA 21 addresses the allocation of frequency spectrum for ITS purposes. Generally speaking, the Federal Communications Commission (FCC) must consider frequency needs for DSRC and other ITS purposes. More specifically, however, the FCC is directed to complete a rulemaking on allocating spectrum for ITS purposes no later than January 1, 2000. Note: Without saying so, this last point refers to the current ITS America petition before the FCC for spectrum allocation at the 5.8 Ghz Band.

Research and Development (5207) TEA 21 contains a comprehensive ITS research, development, operational test and demonstration program for intelligent vehicles and intelligent infrastructure systems. The program is to give priority for federal funding across five areas:

1. traffic management, toll collection, traveler information or traffic control systems;
2. crash-avoidance and integration of in-vehicle crash protection technologies;
3. human factors research
4. integration of intelligent infrastructure, vehicle and control technologies; and
5. impact of ITS on environmental, weather and natural conditions.

ITS operational tests shall be designed to collect data to permit the objective evaluation of the test results and realize cost-benefit information.

The federal share for operational tests and demonstration programs is not to exceed 80%.

Intelligent Transportation System Integration Program (5208) This is the new "deployment incentives" program. This program requires that US DOT undertake a "comprehensive program to accelerate the integration and interoperability of ITS in metropolitan and rural areas." Through competitive selection process, the Secretary of Transportation is to select projects that improve transportation efficiency, promote safety (including freight movement), increase traffic flow (including intermodal traffic at ports), reduce emissions, or promote tourism.

Priority will be given to deployment projects that:

1. Contribute to national ITS deployment goals and objectives;
2. Demonstrate a strong commitment to cooperation among agencies, jurisdictions and the private sector;

3. Encourage private sector involvement and financial commitment;
4. Demonstrate a commitment to a comprehensive plan of fully integrated ITS;
5. Are part of approved statewide and metropolitan planning processes and air quality plans;
6. Minimize federal contributions;
7. Ensure long-term operations and maintenance without federal funds;
8. Demonstrate technical capacity for effective operations and maintenance;
9. Mitigate adverse impacts on bicycle and pedestrian safety; and
10. In rural areas, meet other criteria for safety, geographic and regional diversity or economic development.

Projects in metropolitan areas are to be used primarily to integrate ITS infrastructure elements that are either deployed or to be deployed with other sources of funds. In rural areas, deployment funds are to be spent for the installation of intelligent transportation infrastructure elements.

There are, however, certain limits on how much funding can go to a single area and how it can be spent. In any fiscal year, not more than $15 million may be spent in one metropolitan area; not more than $2 million in any one rural area; and not more than $35 million in one state. Moreover, at least 10% of the funds authorized under this program must be spent on ITS deployment in rural areas. The federal share payable from ITS program funding is not to exceed 50%. However, the total federal share (ITS plus other federal-aid funds) may go as high as 80%.

Commercial Vehicle ITS Infrastructure Deployment (5209) This is the second part of the new "deployment incentives" program for ITS in TEA 21 and is funded at approximately one-quarter of the metro/rural deployment program described above. The CVO deployment program's purpose is to advance the technical capability of ITS applications for CVO while promoting deployment across the country. These ITS/CVO systems should improve safety and productivity of commercial vehicles and drivers, and reduce CVO administrative costs and regulatory requirements.

This program will give priority to projects that:

1. Encourage multi-state cooperation and corridor development;
2. Improve safety and operations;
3. Increase efficiency of regulatory inspection process;
4. Advance electronic processing of data;
5. Promote communication of data among the states; and
6. Enhance the safe passage of commercial vehicles within the United States and across international borders.

Similar to the metro/rural deployment program, federal ITS funds shall not exceed 50%; total of federal funds limited to no more than 80%. Also, to the maximum extent possible, federal funds are to be used for activities not carried out by private funds and shall be leveraged with non-federal funds.

Use of Funds (5210) This section places certain general restrictions on how ITS funding can be used. First, there is a $5 million annual limit for outreach and public relations activities. (Training and the publication of research, technical guidance, and the like do not come under this limitation.) Also, ITS funds for operational tests and deployment projects must be used primarily for the development of ITS infrastructure, and not, to the maximum extent possible, the construction of physical highway and transit infrastructure. Last, those applying for ITS funds must submit an analysis of the life-cycle costs of operations and maintenance, if capital costs exceed $3 million, and a multi-year financing and operations plan.

State/Local Sources

Transportation User Fees

Although some state governments have recently found it difficult to increase their state gas tax, it should be carefully examined by local officials for possible implementation on a regional basis for the funding of ITS projects since it is a direct user-paid revenue option that can raise relatively large sums of money with low administrative costs, especially if the state will collect the tax and return local revenues to the local government. FHWA estimates that urban areas consume about 400 gallons of fuel per person per year. A one-cent regional motor fuel tax in an area with a population of 100,000 could raise $400,000 per year, while only costing the average driver $4 per year. If a one-cent regional motor fuel tax were implemented in Sedgwick County (1997 US Census estimated population of 438,679), as much as $1.75 million dollars could be raised each year. However, state legislation may be needed before a local government could levy any such motor-fuel tax.

Billboard Fees

Some transportation financiers have suggested a "user fee" for off-premise billboard advertising. The logic behind this idea is that since advertising would be useless without streets and highways, advertisers and/or sign owners could be charged a user fee based on the size of their sign and the daily traffic count of the adjoining highway. Although there are no known jurisdictions that currently impose such a fee, it is similar to the currently accepted practice of transit properties receiving small amounts of advertising revenue from messages placed inside or outside buses and subway cars.

Public/Private Sources

Implementation of an intelligent transportation system will likely involve partnerships with private industry, businesses and the academic community. In fact, the primary providers of traffic information are currently private entities that provide radio and television traffic reports. The extent of the partnerships that will be formed depend on several things. First, the need for partnerships must be adequately communicated and understood. Understanding can be enhanced by an intensive program to explain the goals and objectives of ITS and how these goals can be enhanced through partnerships. Second, public technical assistance (for example, to enhance coordination with local jurisdictions) should be made available where possible, and its availability should be made explicit. Third, resources are limited in all sectors of society, and the benefits of participation for all affected entities should be examined and carefully delineated.

Communications Partnerships

ITS projects can require significant communication bandwidth capacities depending on the amount of data and/or video that may need to be transmitted. In addition, many telecommunications companies have specific right-of-way needs for the installation of new fiber-optic communications networks to better serve their customers' data-transmission needs. Therefore, a number of cooperative opportunities now exist that can unite private-sector needs with public-sector resources, and public-sector needs with private-sector resources. For example, public-sector resources such as significant "vacant" right-of-way strips along freeways and some major arterials can be exchanged to satisfy public-sector data/video communication bandwidth capacity needs. Similarly, private-sector resources such as extensive fiber-optic cable networks can be exchanged to satisfy private-sector needs of narrow strips of right-of-way that may be used to install conduit and additional fiber-optic cables.

Some jurisdictions are utilizing this concept with much success by trading a portion of agency-owned right-of-way to a telecommunications company that wishes to install fiber-optic cables in exchange for that agency's right to use a pre-defined amount of fiber-optic bandwidth for either no fee or a significantly reduced fee. Furthermore, additional benefits can be derived from these types of partnerships because of the ability to leverage significant amounts of additional Federal transportation dollars now that Federal law allows private donations to be credited towards the matching funds that state/local agencies must provide for Federal-aid projects. In fact, an arrangement with Digital Teleport Inc. to provide a fiber optic backbone in conjunction with their system installation has been negotiated by KDOT.

Value-Added Partnerships

The National Weather Service obtains needed dollars by selling their "raw" weather data to cable television's *The Weather Channel*, which repackages it into useable "information" for "re-selling" to the public through advertisements on their network. In a similar manner, some transportation agencies are obtaining needed ITS operational funds by selling their "raw" traffic data to similar "value-added" service providers who specialize in converting and repackaging this data into public-useable "information". This information is then re-sold to radio stations, TV stations and/or other interested parties such as digital paging service providers. It must be noted, though, that the legality of this type of partnering, which amounts to the government selling publicly-obtained information on a for-profit basis, has not formally been approved or disapproved by any State or Federal Attorney Generals' offices.

Early Deployment Profit Sharing

In what may at first seem to be a reverse variation of the above value-added partnerships scenario, Early Deployment Profit Sharing can be a way for public entities to accelerate the deployment of specific ITS User Services that neither the public-sector nor the private-sector may be able to do entirely on their own.

An example of this, in a City similar in size and character to Wichita, is the ARTIMIS system recently deployed in Cincinnati, Ohio.

The greater Cincinnati area is currently served by *SmarTraveler*, an Advanced Traveler Information System (ATIS) operated by SmartRoute Systems[2]. This system, which went on-line in June, 1995, provides current transportation information via telephone for the metropolitan Cincinnati area within the I-275 loop, which encompasses urbanized areas in both Ohio and northern Kentucky. The information provided includes current, route specific information on traffic volumes, travel times, and alternate routes, if necessary. Schedule information on transit and airport shuttles, as well as carpools, is also available. Calls for traveler information are free local calls; cellular calls through selected cellular providers are also free of charge. After dialing

[2] Discussion of this system is based on information provided by SmartRoute Systems.

the seven digit phone number or three digit cellular number, an audio menu is provided, this allows specific information to be selected on any of 16 travel routes in the area.

Current reports about traffic conditions are provided from 6 a.m. to 7 p.m., Monday through Friday. Information regarding special events and construction activities is available 24 hours a day. The information provided is based on a variety of sources, including 15 remote-controlled CCTV cameras, two aircraft, a network of "mobile probes" (drivers who report traffic conditions by cellular phone or two-way radio), direct contact with transit agencies and shuttle services, radio contact with law enforcement and emergency responders, and direct communication with key state and local transportation agencies.

Cincinnati's *SmarTraveler* is the first phase of the Cincinnati/Northern Kentucky area's Advanced Regional Traffic Interactive Management & Information System (ARTIMIS). Funding for the system is provided primarily by the Federal Highway Administration under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Kentucky and Ohio also provide state funds for the service. The ARTIMIS system operates under the authority of the Kentucky Transportation Cabinet (KYTC), the Ohio Department of Transportation (ODOT), and the OKI Regional Council of Governments. ARTIMIS includes detectors, variable message signs, area-wide highway advisory radio coverage, and freeway service patrols in addition to the *SmarTraveler* system. The total cost for ARTIMIS is approximately $35 million.

During the first 18 months of the contract, SmartRoutes built and is operating their own facility to provide Advanced Traveler Information Systems (ATIS) for the Cincinnati area. For the remaining 21 months of the 39 month contract, SmartRoutes will operate the facilities currently being built by the Kentucky and Ohio Departments of Transportation. The public sector commits to purchase services for a specified period of time. SmartRoute Systems is also responsible for staffing and operating the center. A center such as the one in Cincinnati can be in operation within six months of the decision to implement. In some cases, negotiated agreements are entered for profit sharing with public agencies of the profits from sales of the database to private entities, such as cellular phone companies and paging companies.

The sale of information to private entities does raise the issue of equity. The philosophy generally expressed is that as long as the public has free access to the information (in this case via telephone), information can justifiably be sold to private entities.

Implementation of a TOC through a private entity should be considered in Wichita. The fast implementation time, coupled with the fact that this system would relieve KDOT and the City of staffing and operation duties (at least in the short term), makes the option quite attractive. Finally, implementation of a system such as this one would allow KDOT and the City to gain experience in TOC operations prior to implementation and operation of their own TOC. Finally, this kind of arrangement would allow the traffic management system to be initiated prior to the construction of the 911 Center.

Academic Input

The academic community may be able to play an important role as well. Academic institutions are not only employers, but are also able to undertake a role in research and training. Coordination with academic institutions, such as Kansas State University, may include employment of student interns and participation in cooperative education programs, the provision of data for research and educational efforts, and student tours of the TOC. Bringing the academic community into the ITS programs can significantly broaden the approach to both the technical and institutional arrangements that are essential to the success of the program.

Coordination with area colleges and universities can be pursued. Possible activities include:

- Provision of data and video feed to regional colleges for research and educational activities.
- Research in transportation technology.
- Training in transportation fields, using teaching expertise at the colleges.
- Receiving information about transportation for use by their students.
- Developing kiosks to display information.

Information Dissemination

KDOT, working with other agencies, can develop and market the information that can be provided externally as a result of implementation of various ITS components. One of the principal methods of information delivery that has been repeatedly suggested is the use of on-line technology. This technology can include a home page, with instructions on how to access the information. It can be free of charge or it can include methods of subscription which require payment in return for a password for access to the information. Another method of delivery of transportation information is to a distribution source. Both of these methods make use of existing communication network technology for distribution of transportation information. These alternatives and others should be explored in greater detail.

Tests of information dissemination might be pursued with employer human resource departments, who have an interest in safe and timely travel by employees. CCTV cameras on the freeway would be transmitted to employment centers and would allow people to see the traffic conditions on the highways prior to beginning their trips. They could then make decisions about travel path or time of travel based on that information. Information might be transmitted to a commuter at home via telephone, fax, television, Internet, or to individual desk PCs for display at work. Another possibility is distribution of information via personal pagers. The pager distributor will, for a fee, provide subscribers with traffic alerts on specific routes that the customer has requested as part of their paging plan.

The kiosk is another technology for distribution of information that is now being explored in several metropolitan areas. KDOT may want to know more about its potential for the distribution of information to employment locations in the future.

Coordination with local trucking agencies, as well as local cab and shuttle services may also be initiated. These entities might be sources of information and also consumers of current traffic information to aid in their deliveries and reliance on the roadway network for safe and timely distribution of its products.

6.6 CONTRACTING ALTERNATIVES

Discussions regarding contracting alternatives are most easily looked at as discussions regarding the different ways in which various degrees of risk and responsibility can be traded amongst the parties participating in a project such that the choosing of the proper contracting alternative develops the desired results rather than the possibility of unintended and/or undesirable consequences. For example, the difference between a project's success or failure may depend on who or what organization has the authority and/or ultimate responsibility for determining system goals, objectives, developing system designs, creating system specifications, letting system contracts, making system changes, authorizing/financing system changes, and/or making the system work as intended. In addition, it is also important to recognize that whoever has the above responsibilities should have the proper technical competence to efficiently and effectively exercise their contractual authority.

The following sections provide insight into the above issues and a recommended course of action regarding which type of contract is best suited for ITS implementation in the Wichita metropolitan area. However, even though this focus is on a recommended type of contract (Consultant/Contractor, System Manager, or Design/Build), it is important to note that the choosing of any particular contracting type does not necessarily require the choosing of any particular contracting method (Time and Materials, Firm-Fixed-Price, Cost Plus Fixed-Fee, etc.). The latter decision can often be made on a contract by contract basis during bid requesting and/or negotiations between the agency and the consultant, contractor, system manager, and/or design/build team.

Existing Agency Methodologies

Transportation Agency Practices

Transportation agencies have much experience and established procedures for procuring equipment and services for highway and bridge construction projects, as well as for obtaining design assistance for these types of projects. The following sections describe the established relationships between a transportation agency and contractors, and a transportation agency and consultants.

Construction Contracts

To assure open and competitive bidding on government contracts, a process has evolved whereby transportation agencies have traditionally awarded contracts to the lowest bidder. To assure quality, many transportation agencies, including KDOT, have developed well defined processes and have also developed detailed criteria whereby contractors must first be prequalified in order to even bid on certain projects. Then, contracts are awarded to the lowest prequalified bidder. This may work in theory on non-complex projects to prevent unqualified contractors from being awarded a job as the low bidder. However, marginal contractors or sometimes even non-qualified contractors can often be prequalified because the DOT's are afraid of potential litigation if they reject a given contractor's prequalification request. Under this scenario, when it comes time to award a contract, a truly unqualified but prequalified bidder can end up winning a contract if they are the lowest bidder. This can be especially problematic in ITS-related procurements since transportation agencies do not usually have enough in-house expertise to actually determine those contractors who are qualified or not. Furthermore, because transportation agencies are typically very liberal in approving contractual change orders, which effectively transform Firm-Fixed-Price contracts into Cost Plus Fixed-Fee contracts, the potential for cost overruns can be very high since unqualified bidders tend to underestimate the complexity and cost of projects in order to win jobs and later make-up their fee through various types of contractual changes.

Professional Services (Consulting) Contracts

In professional services (consulting) contracts, firms are not prequalified and projects are not necessarily awarded to the lowest bidder. Instead, contracts are awarded on the basis of who is the most technically competent to do a job, irrespective of price. This process, as stated under Title 23 of the United States Code of Laws and required of all contracts in which Federal funds are used, is essentially as follows:

1. An agency identifies the scope of work
2. A selection schedule is established
3. A list of professional firms is compiled
4. Qualification documents are requested
5. Qualification documents are evaluated
6. A shortlist of firms to be interviewed is composed
7. Interviews are conducted
8. Firms are ranked for selection
9. A contract is negotiated with the top-ranked firm. If an agreement cannot be reached, those negotiations are ended and negotiations are begun with the second-ranked firm, and so on down the line, until agreement is reached and a firm is selected
10. All firms involved receive post-selection communications

However, for agencies like KDOT where there is no "across the board" prequalification process for ITS-related professional services, ranking procedures may need to be created. One possibility for creating ranking procedures is to utilize some form of this prior project-specific prequalification procedure. Another possibility for increasing technical evaluation possibilities would be to hire an independent consultant to review the proposals, but that consultant would then not be able to bid on the projects in which they had developed the ranking procedures. This would potentially deprive the DOT of valuable sources of knowledge from consultants who might have otherwise been able to make significant contributions to a project's actual implementation. Furthermore, a lack of ITS-experienced personnel in a DOT's Contracts Office may put the agency at a significant disadvantage when it comes time to negotiate the multiple contracts for ITS design and implementation that may be required by this above selection process.

NASA/Department of Defense Models

In contrast to the above traditional transportation methodologies of explicit contractual separation between the design and implementation stages of a project, both the National Aeronautics and Space Administration (NASA) and the United States Department of Defense (DOD) typically utilize contractual unity between a project's design and implementation stages, especially on large-scale/complex programs that may consist of multiple sub-systems requiring integrated command, control, and intelligence; programs with challenges similar to those found with ITS.

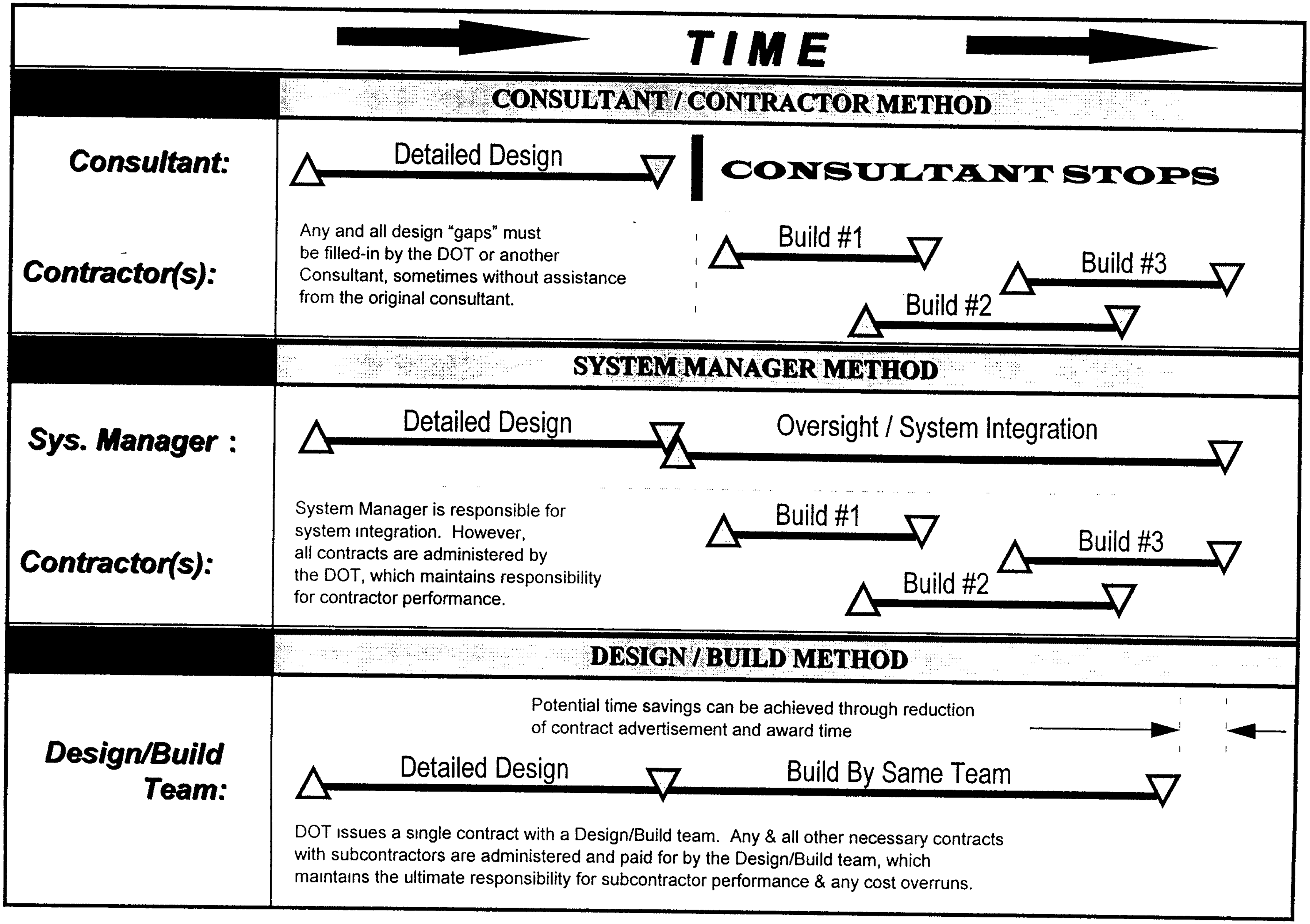
For example, when the DOD needs a new airplane it does not contract with McDonnell Douglas for the design, and then have it built by a team headed-up by the Lockheed Corp. A major reason for this is that not all of a designer's knowledge can ever be transferred from their brains into contracting documents, therefore something inevitably ends-up being left out. Furthermore, when looking at formal contracting arrangements on complex projects like airplanes or ITS, it is important to understand that risk is directly related to cost. In other words, the more a bidder knows about a project or the agency developing a project, the smaller the amount of risk dollars that need to be added to a bid by a contractor. Conversely, the less one knows about a project, the greater the amount of risk dollars that need to be added to a bid, thus increasing the cost of a project. This is especially evident in either a NASA or a DOD project environment because major change orders are rarely approved. Unlike their DOT counterparts, NASA and DOD Firm-Fixed-Price contracts are just that, Firm-Fixed-Price. In light of this discussion of risk dollars, it is interesting to note that traditional transportation contracting methods can actually encourage distance relationships between designer and implementor, thus driving up costs. This is further encouraged whenever agency-bidder contact and question/answer times are excessively limited upon release of a Request For Proposals.

Similar to what will be described later in the Design/Build section of this technical memorandum, the path leading to the successful implementation of ITS projects is very similar to the path that has been used by both NASA and the DOD to put humans on the moon. This may not be that evident to DOTs who are accustomed to dealing with bridge or highway projects in which concrete, steel reinforcing bars, and traffic signal heads behave a certain way and can be obtained by multiple vendors since there are established standards. However, many ITS devices do not have established standards and there are a multitude of components that must all work together in order for a project to be successful. Thus, the lesson to be learned is that it is no longer adequate to solicit items on a piece-by-piece basis for complex ITS implementations that require a systems integrator. The potential is too high for many dollars to be unnecessarily spent if there is too much distance between the agency, the design organization, and the implementation organization.

Formal Contracting Arrangements

As shown in Figure 6-6, there are three primary approaches for contracting ITS-related system design and implementation projects: Consultant/Contractor, System Manager, and Design/Build. The following sections describe each of these types and some of the major advantages and disadvantages of using them to implement ITS. Included are discussions regarding issues such as implementation schedule, constraints of current procurement laws, availability of qualified contractors, availability of KDOT staff, and number of contracts required.

Figure 6-6 Summary of Contracting Types



Consultant / Contractor

The Consultant/Contractor procurement method is the one typically used for highway projects. It is based on the concept that almost all potential construction options are defined in Federal, state, and local *Standard Specifications for Construction* manuals. It is also based on the concept that critical system parameters can be fully specified and documented in a single set of contract documents such as a Plans, Specifications, and Estimate (PS & E) package, that a single contractor is best suited to implement the project, and that the only criterion of significance for selecting the contractor is the initial bid price. For ITS projects, this approach uses a consultant to perform the feasibility study and system design.

For example, KDOT would issue one contract with a consulting firm to design the system, and then KDOT would issue multiple contracts with different contractors who would implement each of the subsystems that were designed by the original consultant. The implementation contractor is completely responsible for system installation, checkout, documentation, and training. However, the DOT is responsible for installation monitoring activities and making sure that the system components work together and actually perform the functions that they were originally intended to perform.

Advantages

The only advantage to the Consultant/Contractor approach in ITS-related projects is that an agency's basic procurement principles are maintained. Thus, KDOT's contracting office would not have to learn a new system for ITS-related project implementations.

Disadvantages

Any and all design gaps, buildability issues, and system integration during project implementation must be addressed by the DOT or another consultant without assistance from the original consultant since the first consultant's contractual obligations are over at this point. Furthermore, the extensive experience with this process for highway construction has resulted in a very rigid set of procedures and rules within most highway agencies that severely restrict the flexibility of system designers and implementors, and prove to be "...unduly cumbersome and counterproductive when applied to traffic control systems projects involving advanced technologies" [USDOT, FHWA, *Traffic Control Systems, Operations and Maintenance -- Expert Panel Report*, March 10, 1992, p. 21]. It must be remembered that there are no standard specification books for ITS components, and no standard "recipes" that ensure all components will work together as intended. The following provides additional detail regarding some of the various reasons that the Consultant/Contractor approach is frequently ineffective for projects like ITS that involve electronics, computers, and communications equipment. For example:

- **Electronics technology is changing too rapidly.** A new generation of electronics equipment (computers, communications, software, etc.) is available every eighteen months. With a minimal three-year cycle from start of design to completion of construction, two generations of equipment will have evolved. The equipment can be obsolete before it is put into use.
- **Initial low bid is not the most important discriminator of system success and total system cost.** Operations costs, maintenance costs, training costs, equipment upgrade and compatibility, and related life-cycle costs are nearly always larger than initial procurement price. Furthermore, software development and system integration, key elements to the success of a complex system, are low bid items.

- **The complex nature of these projects is often beyond the experience and capability of traditional highway contractors.** However, since a majority of the cost under the Consultant/Contractor approach is generally associated with field construction activities, the prime contractor is often a roadway or electrical contractor that has little or no system integration or software experience.
- **DOTs usually have limited ability to understand and fully specify a complex system involving computers, software, and human interactions.** Furthermore, many of the human-factor issues that relate to system usability are typically addressed during implementation stages because of the need to meet special and unforeseen site-specific DOT user-requirements. For example, the end users of the system must define the operational requirements, but they usually do not have the experience needed to convert their needs into precise and unambiguous system specifications. Conversely, the analysts and software engineers who have to create the system may have limited DOT experience and therefore do not always understand the user's requirements.

Thus, the assumption that enough can be known about a project in order to be able to fully define its characteristics is invalid for ITS projects. Furthermore, with two or more organizations involved in the process, responsibilities of the design and implementation parties can become unclear. For example, due to the numerous parts that would have to be procured by a DOT under separate low-bid contracts, situations such as the possibility of functionally-specified computer cards purchased under one contract not being able to fit into controller cabinets purchased under a separate contract may become commonplace. No matter how well the Consultant/Contractor approach is for traditional highway projects, unless the procuring agency has a detailed and complete understanding of what they are buying, it does not work well for projects involving advanced electronics, computer, and software technologies.

System Manager

The System Manager procurement method divides the project into several sub-projects for each of the various sub-systems with the work overseen by a systems manager, often a consultant, who administers each contract in conjunction with KDOT, and who is responsible for integrating the several hardware and software sub-systems into an overall operating system. The System Manager converts the project plan into preliminary designs and defines sub-systems, develops PS&E packages for sub-systems, helps KDOT oversee the bidding and award of construction contracts, checks the work of implementation contractors, supervises construction, selects and procures computer and communications hardware components, manages the installation of equipment, develops and furnishes the system software, integrates and tests the sub-systems, provides necessary software documentation, and supervises the provision of operator training.

Advantages

As with the Consultant/Contractor approach, the System Manager approach maintains the basic procurement principles that an agency is accustomed to working with. However, the System Manager approach has the additional advantage of focusing on a single organization and defined source of accountability that is responsible for both design and subsequent software/hardware integration, thus avoiding controversies over responsibility for design problems that may arise. The involvement of agency personnel as part of the design team also results in improved coordination and tighter cost controls. Furthermore, because the agreement between the agency and the system manager is a negotiated professional services contract, which can more easily be adapted as project needs are refined, increased flexibility is provided to meet the specific project requirements. This approach also provides for the selection of contractors with specific sets of skills for each of the sub-systems. For example, one contractor can be hired to do the earthwork and install the conduit, while another contractor can be hired to integrate and test the electronics within the communications subsystem.

Disadvantages

A potential disadvantage to the System Manager approach is that detailed specifications must be developed to define each subsystem in order that an agency can receive bids and let contracts for each of the major subsystems. Unlike the Consultant/Contractor approach, since all work is coordinated by a System Manager, many potential and costly changes can be avoided. Thus, any potential disadvantages of the System Manager approach may be outweighed by its potential to provide for a more cost effective method of procurement.

Design/Build

In the Design/Build approach, the DOT issues a single contract with a Design/Build team who is selected to handle all of the work associated with implementing the system. Any and all other necessary contracts with subcontractors are administered and paid for by this single entity, which maintains the ultimate responsibility for subcontractor performance and any cost overruns. For example, the Design/Builder is responsible for all aspects of the system, including detail system design, procurement of all equipment, construction of all system elements, integration of the various sub-systems, and final system checking, tweaking, and operational transfer of a fully functional system to the client. Except for the Design/Build feature of transferring all responsibility from a DOT to the Design/Build team, it is in practice very similar to the System Manager approach. However, unlike the System Manager approach where a DOT is ultimately responsible for all contracts, the consultant negotiates, lets, and is responsible for all contracts for equipment procurement and installation.

Advantages

Since the Design/Build approach combines both the design and construction of an ITS-related project into a single contract, it can result in a better understanding of the designer's intent by the builder, minimize the schedule overruns that result from potential conflicts and communication gaps between designers and implementors, potentially decrease the number of after-bid changes, and reduce completion times by streamlining the equipment procurement process by allowing critical components to be ordered and sub-contracts let as soon as engineering details are completed. Design/Build also eliminates time consumed in bid preparation and contract award analysis for separate architectural, engineering, and/or contractor entities while at the same time retaining competition through one unified Design/Build price proposal.

Disadvantages

A disadvantage to the Design/Build approach is that it places a significant burden on the procuring agency to oversee the design and implementation activities and to ensure conformance to the design concept. These are activities that many traditional transportation agencies may not have the in-house expertise to accomplish. This is best expressed by the following: At their best, design-build procurements can serve to streamline the development process and free the private sector to exercise ingenuity and creativity in packaging and delivering construction solutions. But, at their worst, they can distance the owner and user from design influence and decision-making, decrease the participation of professional designers, and shift the onus for quality control and public accountability primarily to the customer. It is up to the procuring agency to determine the extent that they wish to be involved in any type of ongoing Design/Build review process. However, it should be mentioned that it can be especially detrimental to results if an agency chooses the "hands-off" approach since the agency personnel with direct operational experience and needs would then not be involved with the detail design, and thus could not provide input and feedback during design and implementation. It is therefore critical for an agency to know exactly what they want, and to establish a framework which effectively ensures its delivery. To support this, it is possible to hire a second, independent, consultant to help develop the necessary scope of work and to help oversee the design and implementation activities of the primary Design/Build consultant.