



## **STRATEGIC DEPLOYMENT PLAN**

### **INTELLIGENT TRANSPORTATION SYSTEM (ITS)**

**Early Deployment Study  
Kansas City Metropolitan Bi-State Area.**

*Submitted to*

**Kansas Department of Transportation  
Missouri Highway and  
Transportation Department**

*Submitted by*

**HNTB CORPORATION  
Edwards & Associates, Inc.  
AlliedSignal Technical Services Corporation**

# ITS Early Deployment Study Steering Committee Participants

---

| Name             | Agency   |
|------------------|--|
| Bill Ahrens      | Kansas Department of Transportation            |
| Bob Alva         | Federal Highway Administration                 |
| Bruce Baldwin    | Federal Highway Administration                 |
| Jason Cowin      | Federal Highway Administration                 |
| Michael Curtit   | Missouri Highway and Transportation Department |
| Bill Derrick     | Mid-America Regional Council                   |
| Edward M. Halter | Kansas Department of Transportation            |
| Hank Krull       | Missouri Highway and Transportation Department |
| Juanita Lowe     | Kansas Department of Transportation            |
| Steven McDonald  | Missouri Highway and Transportation Department |
| Jim Plumb        | Missouri Highway and Transportation Department |
| Harry Price      | Missouri Highway and Transportation Department |
| Dale Ricks       | Missouri Highway and Transportation Department |
| Norm Schemmer    | Mid-America Regional Council                   |
| Virgil Stiffler  | Federal Highway Administration                 |
| Marvin Sturgeon  | Missouri Highway and Transportation Department |
| Bob Thomas       | Federal Highway Administration                 |
| Jim Tobaben      | Kansas Department of Transportation            |
| Tony Wall        | Federal Highway Administration                 |
| Steven Worley    | Missouri Highway and Transportation Department |
| Stan Young       | Kansas Department of Transportation            |

# Table of Contents

Each Chapter Is A Hyperlink To That Chapter

|  |      |
|--|------|
| EXECUTIVE SUMMARY .....  | ES-1 |
| <br>   |      |
| CHAPTER 1 INTRODUCTION .....                                       | 1-1  |
| Introduction .....   | 1-1  |
| Participating Agencies .....                                       | 1-1  |
| Intelligent Transportation Systems .....                           | 1-1  |
| Focus of ITS Study .....   | 1-2  |
| Focus of Strategic Deployment Plan .....                           | 1-3  |
| Organization of Report .....                                       | 1-3  |
| <br>   |      |
| CHAPTER 2 TRANSPORTATION SYSTEM CHARACTERISTICS .....              | 2-1  |
| Jurisdictions and Affected Agencies .....                          | 2-1  |
| Major Facilities in the Kansas City Area .....                     | 2-1  |
| FREEWAYS .....   | 2-1  |
| ARTERIALS .....  | 2-3  |
| TRANSIT FACILITIES AND SERVICES .....                              | 2-4  |
| INTERMODAL FACILITIES .....  | 2-5  |
| PLANNED FACILITIES .....   | 2-5  |
| Current and Planned ITS Applications in the Kansas City Area ..... | 2-8  |
| AUTOMATIC VEHICLE LOCATION SYSTEMS .....                           | 2-8  |
| HIGHWAY ADVISORY RADIO .....                                       | 2-9  |
| FIBER OPTIC CABLE .....  | 2-9  |
| ELECTRONIC TOLL COLLECTION .....                                   | 2-9  |
| PUBLIC TRANSIT .....   | 2-10 |
| TRAFFIC INFORMATION .....  | 2-10 |
| EMERGENCY VEHICLE SIGNAL PRE-EMPTION .....                         | 2-11 |
| TRAVELER INFORMATION .....   | 2-11 |
| MOTORIST ASSISTANCE PATROL .....                                   | 2-11 |

|   |             |
|---|-------------|
| <b>System Characteristics</b> .....   | <b>2-13</b> |
| FREEWAY TRAFFIC VOLUMES .....   | 2-13        |
| FREEWAY ACCIDENTS .....   | 2-14        |
| FREEWAY TRAVEL TIMES .....  | 2-15        |
| ARTERIAL SIGNAL SYSTEMS .....   | 2-15        |
| TRANSIT RIDERSHIP .....   | 2-17        |
| <b>Institutional Characteristics</b> .....                                  | <b>2-17</b> |
| TOWING OPERATIONS .....   | 2-18        |
| OPPORTUNITIES .....   | 2-20        |
| INSTITUTIONALIZATION OF EARLY DEPLOYMENT PLAN.....                          | 2-21        |
| <br>  |             |
| <b>CHAPTER 3 USER SERVICES</b> .....  | <b>3-1</b>  |
| <br>  |             |
| <b>Agency Perceptions of Local Applicability of ITS User Services</b> ..... | <b>3-1</b>  |
| TRAVEL AND TRANSPORTATION MANAGEMENT .....                                  | 3-1         |
| TRAVEL DEMAND MANAGEMENT .....  | 3-6         |
| PUBLIC TRANSPORTATION MANAGEMENT .....                                      | 3-8         |
| ELECTRONIC PAYMENT .....  | 3-10        |
| COMMERCIAL VEHICLE OPERATIONS .....   | 3-11        |
| EMERGENCY MANAGEMENT .....  | 3-15        |
| ADVANCED VEHICLE SAFETY SYSTEMS.....  | 3-16        |
| <br>  |             |
| <b>Agency Rankings of ITS User Services</b> .....                           | <b>3-18</b> |
| HIGHEST PRIORITY .....  | 3-18        |
| MEDIUM-HIGH PRIORITY.....   | 3-20        |
| MEDIUM PRIORITY.....  | 3-20        |
| LOW PRIORITY .....  | 3-21        |
| <br>  |             |
| <b>Public Involvement Activities</b> .....                                  | <b>3-21</b> |
| SURVEY RESULTS .....  | 3-22        |
| <br>  |             |
| <b>Performance Criteria for ITS User Services</b> .....                     | <b>3-23</b> |
| MEASURES OF EFFECTIVENESS .....   | 3-25        |
| PERFORMANCE CRITERIA FOR HIGHEST PRIORITY USER SERVICES.....                | 3-26        |
| PERFORMANCE CRITERIA FOR MEDIUM-HIGH PRIORITY USER SERVICES.....            | 3-28        |
| <br>  |             |
| <b>Intelligent Transportation Infrastructure (ITI)</b> .....                | <b>3-30</b> |
| ITI PRINCIPLES .....  | 3-32        |
| KEY CONSIDERATIONS FOR DEPLOYMENT.....                                      | 3-32        |
| <br>  |             |
| <b>Short, Medium, and Long Term ITS User Services</b> .....                 | <b>3-33</b> |
| EXISTING OR PLANNED ITS USER SERVICES .....                                 | 3-35        |
| USER SERVICES FOR DEPLOYMENT IN THE SHORT TERM.....                         | 3-35        |
| USER SERVICES FOR DEPLOYMENT IN THE MEDIUM TERM .....                       | 3-36        |
| USER SERVICES FOR DEPLOYMENT IN THE LONG TERM .....                         | 3-36        |

|   |             |
|---|-------------|
| <b>CHAPTER 4 SYSTEM ARCHITECTURE .....</b>                        | <b>4-1</b>  |
| <b>Alternatives Considered .....</b>                              | <b>4-1</b>  |
| CHARACTERISTICS.....  | 4-1         |
| <b>Evaluation Criteria.....</b>                                   | <b>4-4</b>  |
| <b>Analysis Procedure.....</b>                                    | <b>4-6</b>  |
| UTILITIES.....  | 4-6         |
| COSTS.....  | 4-7         |
| UTILITY-COST FACTOR.....  | 4-7         |
| <b>Recommended Architecture.....</b>                              | <b>4-9</b>  |
| <br>  |             |
| <b>CHAPTER 5 TECHNOLOGIES.....</b>                                | <b>5-1</b>  |
| <b>Types of Technologies .....</b>                                | <b>5-1</b>  |
| <b>Monitoring Technologies.....</b>                               | <b>5-2</b>  |
| VEHICLE DETECTION.....  | 5-2         |
| CLOSED CIRCUIT TELEVISION.....                                    | 5-10        |
| ELECTRONIC TOLL AND TRAFFIC MANAGEMENT .....                      | 5-14        |
| <b>Communications Technologies.....</b>                           | <b>5-15</b> |
| FIBER OPTIC CABLE .....   | 5-15        |
| FIBER OPTIC NETWORK CONFIGURATIONS.....                           | 5-17        |
| COMMERCIAL COMMUNICATIONS CIRCUITS .....                          | 5-18        |
| AGENCY OWNED FACILITIES.....                                      | 5-22        |
| <b>Traveler Interface Technologies .....</b>                      | <b>5-24</b> |
| VARIABLE MESSAGE SIGNS .....                                      | 5-24        |
| HIGHWAY ADVISORY RADIO.....                                       | 5-30        |
| KIOSKS.....   | 5-34        |
| DIAL-IN SYSTEMS.....  | 5-34        |
| <b>Data Processing .....</b>                                      | <b>5-34</b> |
| DETECTOR DATA PROCESSING.....                                     | 5-34        |
| INCIDENT DETECTION ALGORITHMS.....                                | 5-37        |
| <b>Strategies Evaluation.....</b>                                 | <b>5-41</b> |
| POTENTIAL IMPROVEMENT OPTIONS FOR TRANSPORTATION MANAGEMENT ..... | 5-42        |
| ITS ACTIVITIES IN OTHER URBAN AREAS .....                         | 5-50        |
| <b>Public Transportation Technologies.....</b>                    | <b>5-59</b> |
| EN-ROUTE TRANSIT INFORMATION .....                                | 5-61        |
| PUBLIC TRAVEL SECURITY.....                                       | 5-63        |
| PUBLIC TRANSPORTATION MANAGEMENT.....                             | 5-63        |

|   |                |
|---|----------------|
| <b>CHAPTER 6 BENEFITS AND COSTS .....</b>                           | <b>6-1</b>     |
| <b>Introduction .....</b>   | <b>6-1</b>     |
| <b>Estimated Benefits - Freeway Management System.....</b>          | <b>6-1</b>     |
| <b>Estimated Costs - Freeway Management System.....</b>             | <b>6-5</b>     |
| <b>Benefit Cost Ratios - Freeway Management System.....</b>         | <b>6-5</b>     |
| PROVISION OF FIBER OPTICS CABLE IN KANSAS .....                     | 6-11           |
| <b>Future Prioritization for Freeway Management System.....</b>     | <b>6-13</b>    |
| CALCULATION OF BENEFITS .....                                       | 6-13           |
| CALCULATION OF COSTS .....  | 6-15           |
| BENEFIT COST RATIO.....   | 6-16           |
| <b>Estimated Benefits and Costs - ITS Transit Applications.....</b> | <b>6-17</b>    |
| BENEFITS.....   | 6-17           |
| COSTS.....  | 6-18           |
| <br><b>CHAPTER 7 DEPLOYMENT.....</b>                                | <br><b>7-1</b> |
| <b>Freeway Management Applications .....</b>                        | <b>7-1</b>     |
| SHORT, MEDIUM, AND LONG TERM PRIORITIES .....                       | 7-1            |
| DEPLOYMENT SCHEDULE.....  | 7-2            |
| GUIDE TO DEPLOYMENT.....  | 7-11           |
| OPERATIONS PLAN.....  | 7-18           |
| <b>Public Transportation Applications .....</b>                     | <b>7-24</b>    |
| <b>Interagency Coordination .....</b>                               | <b>7-26</b>    |
| AGENCY ROLES AND RESPONSIBILITIES .....                             | 7-26           |
| DEPLOYMENT ISSUES.....  | 7-30           |
| <b>Funding Issues .....</b>   | <b>7-32</b>    |
| POTENTIAL FUNDING SOURCES.....                                      | 7-32           |
| PUBLIC/PRIVATE PARTNERSHIPS.....                                    | 7-32           |
| PROCUREMENT METHODS.....  | 7-35           |
| <b>Conclusions.....</b>   | <b>7-37</b>    |
| <br><b>Appendix A &amp; B</b>                                       |                |

# List of Figures

Figures located at the end of each chapter

**The List of Figures are hyperlinked to open the appropriate Chapter**

| <b>Figure</b> | <b>Title</b>   |
|---------------|--|
| ES-1          | Deployment Phases  |
| ES-2          | ITS Short Term Priorities  |
| 2-1           | Freeways and Major Arterials in Kansas City Area   |
| 2-2           | Intermodal Facilities in Kansas City Area  |
| 2-3           | Potential HOV Network in Kansas City Area  |
| 2-4           | Light Rail Preferred Alternative in Kansas City, Missouri                                |
| 2-5           | Daily Traffic Volumes on Major Freeway Facilities  |
| 2-6           | Daily Traffic Volumes/Lane on Major Freeway Facilities                                   |
| 2-7           | Future Traffic Volumes on Major Freeway Facilities                                       |
| 2-8           | Future Traffic Volumes/Lane on Major Freeway Facilities                                  |
| 2-9           | Accident Rates on Major Freeway Facilities   |
| 2-10          | High Accident Locations on Major Freeway Facilities                                      |
| 2-11          | Travel Speeds on Major Freeway Facilities in Morning Peak Period                         |
| 2-12          | Travel Speeds on Major Freeway Facilities in Evening Peak Period                         |
| 2-13          | Areas of Concern on Major Freeway Facilities as Indicated in MARC's<br>Congestion Survey |
| 2-14          | Selected Arterial Signal Systems   |
| 2-15          | Transit Routes   |
| 4-1           | Geographic Extent ITS System   |
| 5-1           | Examples of ITS Technologies and Applications  |
| 5-2           | Fundamental Volume-Occupancy Relationship  |
| 6-1           | Diagram of Freeway Management System   |
| 6-2           | Annual Benefits Expected Due to Freeway Management System                                |
| 6-3           | Deployment Phases  |
| 7-1           | Priority Closed Circuit Television Camera Locations                                      |
| 7-2           | Idealized Highway Advisory Radio Coverage  |
| 7-3           | Variable Message Sign Locations and Possible Diversion Routes                            |
| 7-4           | Principal Components of a Pretimed Ramp Control  |
| 7-5           | Typical Single and Dual Lane Ramp Metering Placement                                     |
| 7-6           | Potential Ramp Meter Locations I-35 Corridor   |

# List of Tables

Tables are hyperlinked to open the appropriate Chapter

| Table | Title   | Page |
|-------|---|------|
| ES-1  | Benefit Cost Ratio for Each Phase .....   | ES-2 |
| 2-1   | Emergency Management Service in Kansas City .....   | 2-2  |
| 2-2   | Travel Characteristics in the Kansas City Area .....  | 2-3  |
| 2-3   | Fixed Route Transit System Characteristics in the Kansas City Area .....                                      | 2-4  |
| 2-4   | Transit Use of Freeways .....   | 2-18 |
| 3-1   | Travel and Transportation Management User Services .....  | 3-2  |
| 3-2   | Travel Demand Management User Services .....  | 3-6  |
| 3-3   | Public Transportation Management User Services .....  | 3-8  |
| 3-4   | Electronic Payment User Service .....   | 3-10 |
| 3-5   | Commercial Vehicle Operations User Services .....   | 3-11 |
| 3-6   | Emergency Management User Services .....  | 3-15 |
| 3-7   | Advanced Vehicle Safety Systems User Services .....   | 3-17 |
| 3-8   | Overall Priority Rankings of ITS User Services by Local Agencies<br>in Kansas City Area .....                 | 3-19 |
| 3-9   | Priority Rankings of Transit Related User Service by Local Transit<br>Agencies in Kansas City Area .....      | 3-18 |
| 3-10  | Performance Criteria and Sample Measures of Effectiveness .....   | 3-24 |
| 3-11  | Performance Criteria for Highest Priority User Services .....   | 3-27 |
| 3-12  | Performance Criteria for Medium-High Priority User Services .....   | 3-29 |
| 3-13  | Priority and Implementation Time Frame for ITS User Services .....  | 3-34 |
| 4-1   | Description of System Architecture Alternatives .....   | 4-2  |
| 4-2   | System Architecture Evaluation Criteria .....   | 4-5  |
| 4-3   | Utility for Each Criteria by Architecture Alternative .....   | 4-8  |
| 4-4   | Steering Committee Recommendations for Weighting of Evaluation<br>Criteria .....                              | 4-9  |
| 4-5   | Estimated Cost for Each Alternative Architecture .....  | 4-10 |
| 4-6   | Calculation of Utility Cost Factor for Each Architecture Alternative .....                                    | 4-11 |
| 5-1   | Estimated Costs for Passive Vehicle Detection .....   | 5-8  |
| 5-2   | Major Features of Common Vehicle Detectors .....  | 5-11 |
| 6-1   | Summary of Benefits per Phase for Freeway Management System .....   | 6-2  |
| 6-2   | Benefits by Segment in Kansas .....   | 6-3  |
| 6-3   | Benefits by Segment in Missouri .....   | 6-4  |
| 6-4   | Phase 1 Costs .....   | 6-6  |
| 6-5   | Phase 2 Costs (Incremental Costs) .....   | 6-7  |
| 6-6   | Phase 3 Costs (Incremental Costs) .....   | 6-8  |
| 6-7   | Phase 4 Costs (Incremental Costs) .....   | 6-9  |
| 6-8   | Cost for All Phases .....   | 6-10 |
| 6-9   | Benefit Cost Ratio for Each Phase .....   | 6-11 |
| 6-10  | Estimated Value of Fiber Optic Cable on KDOT Freeways in Kansas<br>City Metropolitan Area .....               | 6-12 |
| 6-11  | Benefit Assessment of Transit Applications .....  | 6-18 |
| 6-12  | Estimated Costs for Transit Applications .....  | 6-18 |
| 7-1   | Program of Space Needs for Traffic Operation Center to be<br>Co-Located with New MHTD District Facility ..... | 7-25 |