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Responsive Multimodal Transportation Management Strategies and IVHS

Research and Development
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FOREWORD

This report presents the results of a study on potential applications of new and emerging intelligent vehicle-highway systems (IVHS) technologies to multimodal transportation systems. It presents 27 candidate multimodal scenarios and discusses their potential benefits, costs, and feasibility as well as related institutional and legal issues. It reflects the view of the authors as well as those of participants in a series of national workshops held to discuss the contents. This report will be of interest to IVHS planners and implementing agencies who may want to consider innovative ways to enhance the operations of highways, transit, paratransit, and goods movement.

Lyle Saxton, Director
Office of Safety and Traffic
Operations Research and Development

NOTICE

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Contracting Officer's Technical Representative (COTR) - Aladdin Barkawi, HSR-10. In carrying out the work a client panel from the FHWA and the Federal Transit Administration (FTA) was formed to review and comment on the project. Subcontractor and consultant support from Farradyne Systems, Inc. (FSI), SG Associates (SGA), and Jerri Brown. Key contributors to thii document included Andrew Sullivan (BMI) and Frank Spielberg (SGA).
Federal Transit Administration.

16. Abstract

The purpose of this study was to investigate new and **innovative** ways to incorporate M-IS technologies into multimodal transportation management strategies. Much of the IVHS research done to date has addressed the modes individually. This project focused on integrating Travel Demand Management (TDM) strategies with the IVHS to provide the **synergy** and the cost saving achievable by utilizing an [assumed] already available IVHS infrastructure for implementation of TDM strategies. Specifically this study was aimed at developing multimodal IVHS applications for: (1) increasing the market share of mass transit, HOV, and ridesharing, (2) enhancing the efficiency of urban goods movement, (3) reducing transportation demand in congested areas, (4) improving mobility in urban and rural areas, (5) improving operations at ports, rail facilities, and airports, and (6) addressing air quality issues. A process was also developed for evaluating the potential utility and costs of these new applications. Supplementing these evaluations were a series of 8 l-day workshops held at sites across the country to obtain input and feedback on these scenarios from transportation professionals.

17. Key Words	18. Distribution Statement
IVHS, multimodal transportation management, ATMS, ATIS, CVO, APTS, mass transit, paratransit, urban goods movement, ports, airports, operational tests.	No Restrictions. This document is available to the public through the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.395	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m2
yd^2	square yards	0.836	square meters	m2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.765	liters	L
ft^3	cubic feet	0.028	cubic meters	m3
yd^3	cubic yards	0.765	cubic meters	m3
	MASS			
oz	ounces	26.35	grams	9
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	^oC
	ILLUMINATION			
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE and PRESSURE or STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

NOTE: Volumes greater than 1000 l shall be shown in m^3.

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm2	square millimeters	0.0016	square inches	in^2
m2	square meters	10.764	square feet	ft^2
m2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km2	square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m3	cubic meters	35.71	cubic feet	ft^3
m3	cubic meters	1.307	cubic yards	yd3
	MASS			
9	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
	TEMPERATURE (exact)			
^oC	Celcius temperature	1.8C + 32	Fahrenheit temperature	"F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE and PRESSURE or STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*$I is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ADA	Americans with Disabilities Act
APTS	Advanced Public Transportation Systems
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVCS	Automated Vehicle Control Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CAAA '90	Clean Air Act Amendments 1990
CVO	Commercial Vehicle Operations
FOCCS	Flexible Operations Command and Control System
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
GPS	Global Positioning System
HAR/TAR	Highway Advisory Radio/Traveler Advisory Radio
HOV	High Occupancy Vehicle
IVHS	Intelligent Vehicle-Highway Systems
SOV	Single Occupant Vehicle
TDM	Transportation Demand Management
TMC	Transportation Management Center
TSM	Transportation Systems Management
VMT	Vehicle-Miles Traveled
WIM	Weigh-In-Motion

1. INTRODUCTION

PURPOSE

This final report presents the candidate multimodal transportation management scenarios that were developed in task B of this study, recommendations for operational tests, and identification of future research needs. Included are descriptions of each scenario and its areas of application, evaluations of its potential utility and cost, and discussions of institutional/legal barriers, human factors, and other implementation considerations. This report also contains a summary of the assumptions made in developing the scenarios, the criteria used for scenario evaluation, the candidate sites selected for presentations, and brief descriptions of discarded scenarios.

BACKGROUND

The objectives of this study are to (1) identify candidate real-time or semi-real-time multimodal transportation management scenarios that utilize new and emerging IVHS technologies, (2) determine their usefulness and feasibility, (3) develop additional innovative concepts, (4) evaluate the potential utility and cost of each scenario, and (5) provide recommendations for additional research, development, and operational tests.

Based on goals and objectives set forth for this study by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), scenarios have been developed which consider approaches that will:

- Improve the market share and operations of High Occupancy Vehicles (HOV), ridesharing, and mass transit.
- Provide for more efficient use of existing transportation facilities and resources.
- Provide for more efficient use of energy resources.
- Enhance the efficiency of urban goods movement.
- Improve the usefulness of existing Transportation Demand Management (TDM) strategies.
- Improve air quality/reduce pollution emissions.
- Improve transportation safety.
- Improve the economic efficiency of transit and paratransit operations.
- Improve the mobility of the elderly, handicapped, and transportation disadvantaged.
- Improve mobility in rural areas.

ASSUMPTIONS

Although Intelligent Vehicle-Highway Systems (IVHS) is currently in the very early stages of development and testing, the scenarios presented in this report were developed for a mature IVHS environment that is assumed will exist at some time in the future. The following assumptions have been made about the expected level of IVHS maturity in the urbanized areas and in major rural highway corridors under implementation consideration for this study:

- Traffic signal control, freeway management, and transit fleet management systems have been deployed throughout most of the area.
- The systems are physically/electronically linked.
- Each location has a Transportation Management Center (TMC) where information is received, fused, and disseminated to travelers directly and via service suppliers that use the information, add value and then provide it to travelers.
- Commercial vehicles are linked to fleet management centers which provide them with traffic and route information.
- There is a large market penetration of in-vehicle navigation devices whereby the above information is provided to drivers of passenger cars, transit vehicles, and commercial vehicles, and recommended routing is provided based on real-time information.
- Reduced scale in-vehicle systems that provide continuous traffic information on selected corridors are also available. They are less sophisticated and less costly than the full functioned ATIS devices described above.
- Traffic information centers and systems, similar to those described above, exist in major rural highway corridors and areas. However, these systems are not deployed throughout the entirety of the rural networks.

Again, the availability of these services were taken as givens during the development and evaluation of the candidate scenarios. The focus of this study is on how the candidate scenarios will perform given this environment. Thus, the study results will allow operational test developers to consider incorporation of various scenarios into their tests. Several of the scenarios are not dependent on a complete IVHS environment and could be incorporated into existing or planned IVHS systems where the needed IVHS elements are available.

One of the key elements in any assumed IVHS environment will be the Transportation Management Center or TMC. For the purposes of this study, the TMC is envisioned as being the “nerve center” of an IVHS system where information from a variety of “sources” is gathered, fused, and disseminated. These “sources” include traffic operations centers such as freeway management centers, traffic signal control centers, and traffic information systems for major highway facilities. At this early stage of IVHS development, the functional requirements of a “TMC” have not been clearly defined.

One model would have the fused traffic information disseminated both directly to travelers and to value added service providers. The directly disseminated data would be used by computer based equipment to provide services, such as selection of best route based on real-time traffic conditions, to travelers having the appropriate equipment. Value added suppliers would customize the data, add additional data, such as for a commercial fleet, and supply services to their users. In the case of a commercial fleet system the services might include fleet management services and customer information.

To further complicate the presentation of this model, many of the value added suppliers/users would in themselves be sources of data.

Potential value added providers/sources include:

- **The Traffic Operations Center:** Included are freeway management centers, traffic signal control centers, and traffic information systems for major highway facilities. The TMC could coordinate the operations of these facilities which often operate independently today. They would use this regional transportation "intelligence information" to better manage their systems in real time.

- **Transit Operations Centers:** Centers which monitor and control the operations of transit buses and rail systems. These centers would **most** likely operate independently but could coordinate their operation with other modes through the TMC.

- **Paratransit/Taxi Dispatch Centers:** Taxi and paratransit operations (of which there are often several in large urban areas) could be coordinated with other modes through the TMC to improve service and efficiency.

- **Rideshare Brokerage Services:** Centers that provide ridematching services could be linked to traffic, transit, and air quality control centers to provide services during major incidents or special events.

- **Commercial Fleet Dispatch Centers:** Centers that monitor and dispatch commercial vehicles could provide useful traffic data and could be linked to traffic operations centers to improve routing and scheduling.

- **ATIS Systems:** Systems that provide traffic information to drivers could be linked with other transportation services to include truly multimodal travel information.

- **Community Services:** Included are police, fire, rescue, weather, and air quality services; and health and human service organizations.

- **Private Enterpreneurs:** That would package the data for such applications as: kiosks; in-home, interactive, cable TV; and traffic/transit call-up services.

The TMC, in this model, will act as a clearinghouse and perhaps act to facilitate coordination of transportation management among the various users/suppliers. The TMC, as envisioned in this model, would not micromanage the transportation system but would instead link the operations of different transportation systems through the exchange of real-time transportation systems through the exchange of real-time transportation information and facilitate coordinated control strategies, particularly when responses are being initiated to incidents or other unusual transportation events.

It should be noted that figure 1 represents an "ultimate" configuration for a TMC. Few TMC's would perform all of the functions illustrated here. The complexity of the TMC will vary with the complexity of the transportation system it serves. The TMC plays a central role in many of the scenarios described in this report.

ORGANIZATION

The remainder of this report is organized as follows. Section 2 presents descriptions of the 27 candidate scenarios developed in task B along with l-page summary evaluations. It also presents a summary of the process and criteria that were used to develop and evaluate the scenarios. It should be noted that the scenarios are presented individually in this report, but in practice a number of scenarios could be combined in a given area. This will not only increase the effectiveness of the scenarios, but should also reduce implementation costs through the shared use of facilities and infrastructure. Section 3 presents discussions of the site selection criteria and the candidate presentation sites. Section 4 presents a summary of those scenarios that should be considered for operational testing and implementation. Section 5 presents scenarios which, though promising, need additional research and development before actual implementation should be considered. Appendix A presents more detailed evaluations for each of the scenarios. Appendix B presents brief descriptions of discarded scenarios and the reasons they were dropped from further consideration. Appendix C is a glossary of terms and acronyms used in this report. Finally, appendix D presents a list of references used in this study.

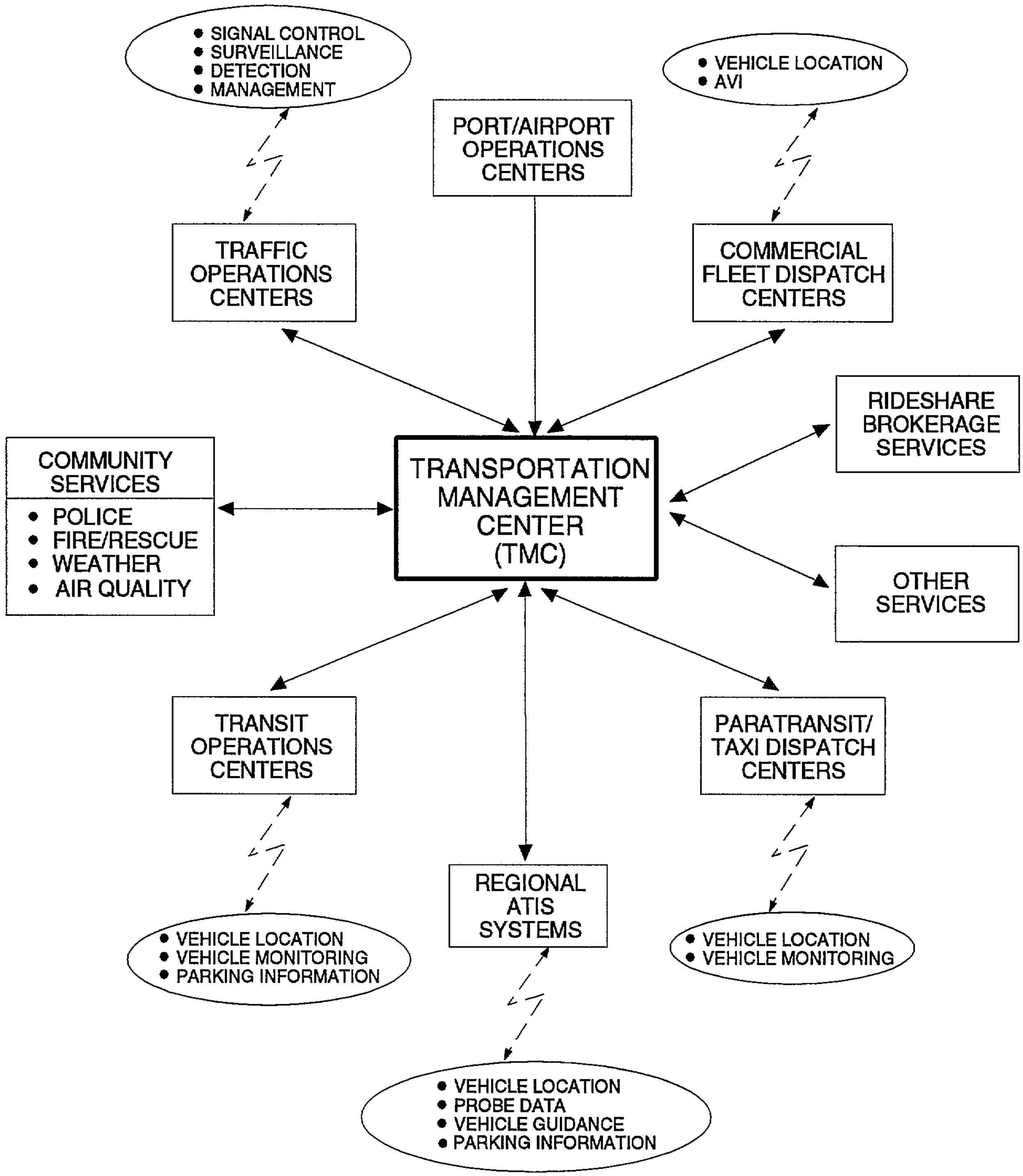


Figure 1. Conceptual role of a TMC in mature IVHS.

2. DESCRIPTION OF CANDIDATE SCENARIOS

OVERVIEW OF DEVELOPMENT AND EVALUATION PROCESS

Figure 2 presents the overall process that was used for identifying, developing, and evaluating the candidate scenarios. Candidate scenarios included some systems that have been previously tried and have not been fully successful. These were identified here as candidate scenarios when it was thought that linkages with IVHS would make them more practical to implement, more useful, and/or more user friendly. Candidate multimodal transportation management concepts were linked with IVHS technologies to yield potential real-time multimodal transportation management scenarios. These scenarios were then examined in a two-part evaluation process. Ten criteria categories along with micro-criteria for each were developed to evaluate the scenarios. In the first evaluation step, a simplified set of screening criteria was used to ensure that the scenarios met the basic objectives of the study and were designed in such a way as to maximize their potential effectiveness while avoiding any obvious obstacles. In the second part, more detailed benefit, cost, legal and institutional, and feasibility criteria were used to refine the scenarios and determine which should be carried forward for possible operational testing. A summary of the 10 criteria categories and selected evaluation criteria are presented in figure 3. These criteria assume that the IVHS environment discussed on page 2 is in place.

Because there is little actual data available from IVHS operational tests, much of the evaluation at this stage was subjective and based on the experience of members of the study team and on information found in the literature. There was no attempt to quantify potential impacts of these scenarios beyond subjective measures such as low, medium, or high. It is the intention of this study to identify scenarios which may hold potential for operational testing and identify some of the key issues that will have to be examined if testing is to take place. The actual quantification of costs, benefits, and impacts will come with the operational testing.

The justification method used for recommending these scenarios included the evaluation process discussed above and, in particular, examinations of the potential utility and ease of implementing each scenario, assessments of the applicability of each scenario to the objectives of this study, inputs from FHWA and FTA personnel, and informal input from transportation professionals who were contacted as part of this study. We included those scenarios that consistently rated high in the evaluation categories, do not possess serious obstacles to success, have elicited strong interest from the transportation community, and were judged to have high implementation potential. We also included some scenarios which, though they did not rate high in all evaluation categories, could provide significant benefits if certain obstacles were overcome. Scenarios that were dropped from further consideration are briefly described in appendix B.

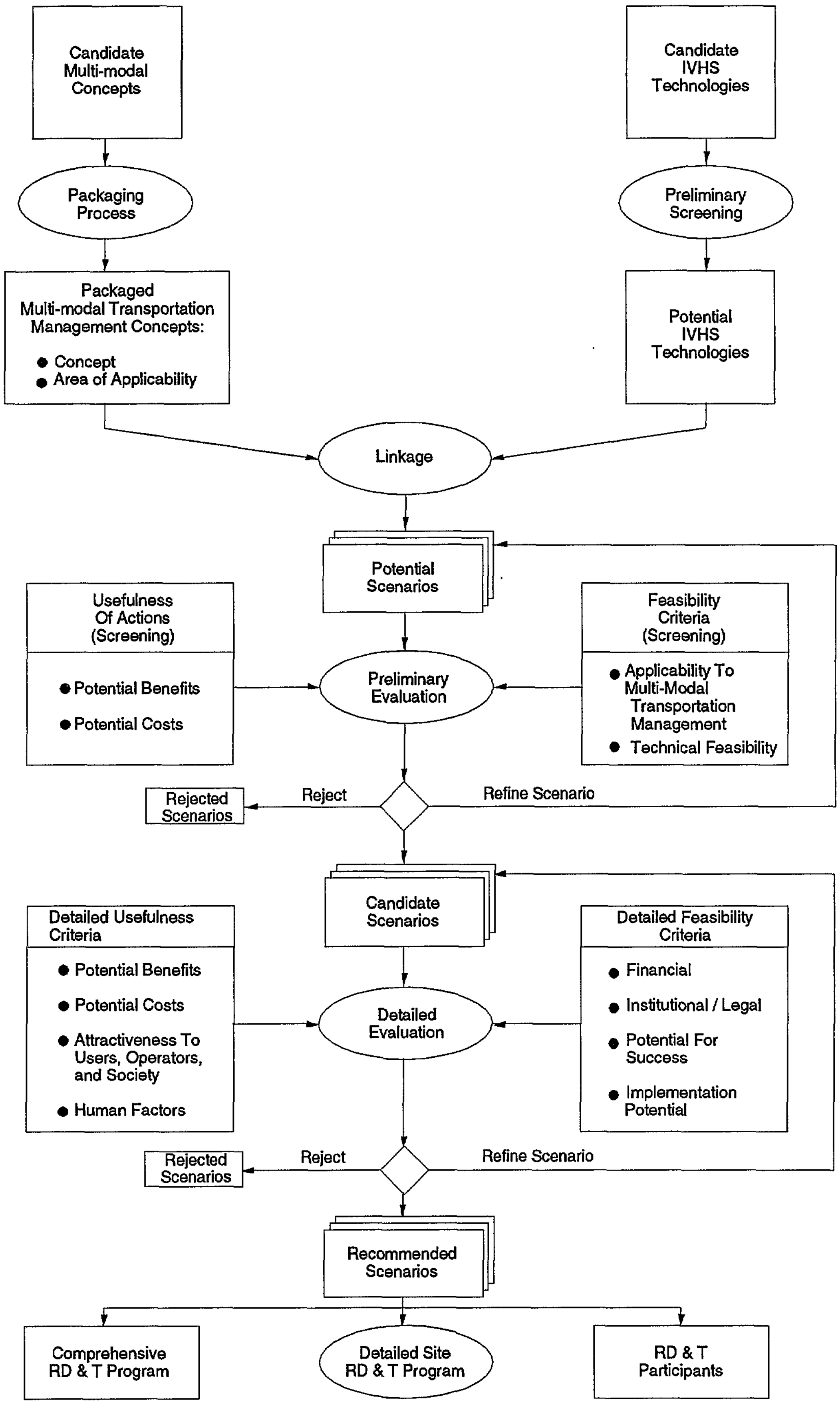


Figure 2. Development and evaluation process.

Listed below are the 10 general criteria categories along with selected evaluation criteria.

1. Applicability to Multimodal Transportation Management - Screening criteria include:

- HOV/Ridesharing utilization
- Coordination with mass transit
- Applications to goods movement
- Compliance with Clean Air Act Amendments ' 90
- Compliance with the Americans with Disabilities Act

2. Technical Feasibility - Screening criteria include:

- Feasibility (need for new technology)
- Flexibility (alternate technologies)
- Reliability
- Expandability & upgradability

3. Potential Benefits - Criteria include:

- Reduced single occupant vehicles
- Congestion reduction & avoidance
- Improve commercial vehicle productivity
- Pollution reduction
- Improved .transit/rideshare operations
- Improved safety
- Energy savings

4. Potential Costs - Criteria include:

- Implementation costs
- Operation & maintenance costs
- Out of pocket user costs
- Non-monetary costs

5. Institutional and Legal Issues - Criteria include:

- Passenger security/safety
- Operator/manufacturer liability
- Need for inter-jurisdictional/inter-agency cooperation
- Opportunity for public/private cooperation
- Legal impediments and regulatory restrictions

6. Financial Feasibility - Criteria include:

- Need for government subsidies
- Potential for commercialization
- User willingness to pay
- Applicability to existing funding programs

7. Attractiveness to Users. Operators and Society - Criteria include:

- Acceptability to management
- Ease of learning system (users and providers)
- User and provider convenience
- Provision of incentives
- Impacts on non-users

8. Human Factors - Criteria include:

- Target audience
- Ability to gain large user population
- Ease of use for all user populations
- Effectiveness in addressing human concerns

9. Potential for Success - Criteria include:

- Potential market penetration
- Long-term viability
- Integratabiiity with other scenarios

10. Implementation Potential - Criteria include:

- Barriers to deployment
- Compatibility with existing systems/modes
- Implementation sequence
- Areas of greatest potential impact (e.g., urban CBD, urban non-CBD, suburban, high activity centers, etc.)

Figure 3. Selected evaluation criteria

The candidate multimodal scenarios are presented in the following sections. Although all scenarios have multimodal applications, they are presented according to their major modal applications:

- Mass transit.
- Paratransit/ridesharing.
- General highway/multimodal.
- Airports.
- Commercial ports/intermodal facilities.

Each scenario is presented first graphically with a short narrative description and is then followed by a summary evaluation of its potential benefits, costs, institutional/legal barriers, financial feasibility, overall attractiveness, human factors considerations, potential for success, and implementation potential. Detailed summary evaluations are presented in appendix A.

MASS TRANSIT SCENARIOS

The following 10 scenarios have been designed to increase transit usage, enhance the efficiency of transit operations, ease transit use, and improve the overall quality of mass transit services provided. The scenarios are as follows:

1. Transit route deviation and dynamic stop requests.
2. Real-time bus location information.
3. Timed transfer management.
4. Transit parking space reservation.
5. Smartcard fare collection.
6. Transit priority on signalized networks.
7. Transit vehicle information displays.
8. Transit schedule reliability.
9. Improved transit management information.
10. Automatic accident data recording.

PARATRANSIT AND RIDESHARING SCENARIOS

The following 5 scenarios were designed to increase the use of HOV and ridesharing, enhance the operations of paratransit services, and generally improve personal mobility in both urban and rural environments. The scenarios are as follows:

11. Real-time ridesharing.
12. Paratransit dispatching.
13. Taxi user-side subsidies with smartcards.
14. Urban goods and passenger movement.
15. Rural ATIS.

GENERAL HIGHWAY/MULTIMODAL SCENARIOS

The following seven scenarios were designed to improve travel on the transportation system and encourage the awareness and use of alternate modes of travel. The scenarios are as follows:

16. Real-time transportation information in homes, workplaces, and stores.
17. Needs scheduling.
18. Air pollution alert.
19. Weather/roadway condition monitoring.
20. ATIS: parking availability.
21. Portable ATIS unit.
22. Traffic management at parks and monuments.

AIRPORT SCENARIO

The following scenario was designed to improve travel and traffic flow at airports.

23. Airport access/passenger pick-up.

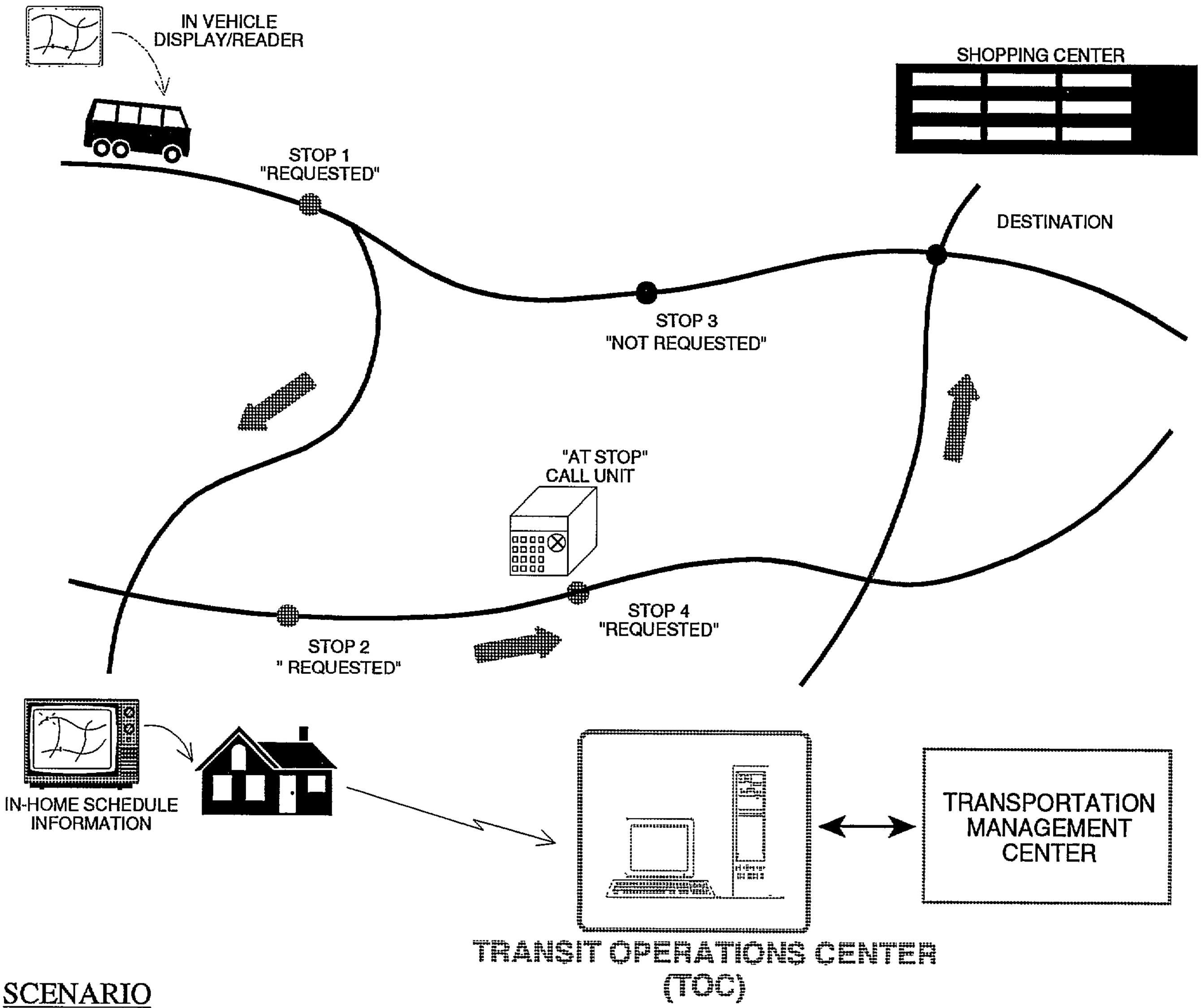
PORTS/INTERMODAL FACILITIES SCENARIOS

The following scenarios were designed to improve the operation and efficiency of intermodal port and rail facilities. They are as follows:

24. Truck access to port/rail facilities.
25. Vehicle processing at port/rail facilities.
26. River and drawbridge coordination.
27. Moving urban goods on ferries.

SCENARIO NO. 1
ROUTE DEVIATION-DYNAMIC STOP REQUESTS AND ROUTING

GOAL: Provide efficient ADA, low-demand, and off-peak service.



SCENARIO

1. Eligible riders enter requests via telephone or at-stop request units.
2. Transit Operations Center routes bus to requested stops, bypassing unrequested stops.
3. Rider uses "Smartcard" for verification and automatic billing.
4. Passengers would enter destinations so that bus would not bypass riders' stops.

Figure 4. Route deviation-dynamic stop requests and routing.

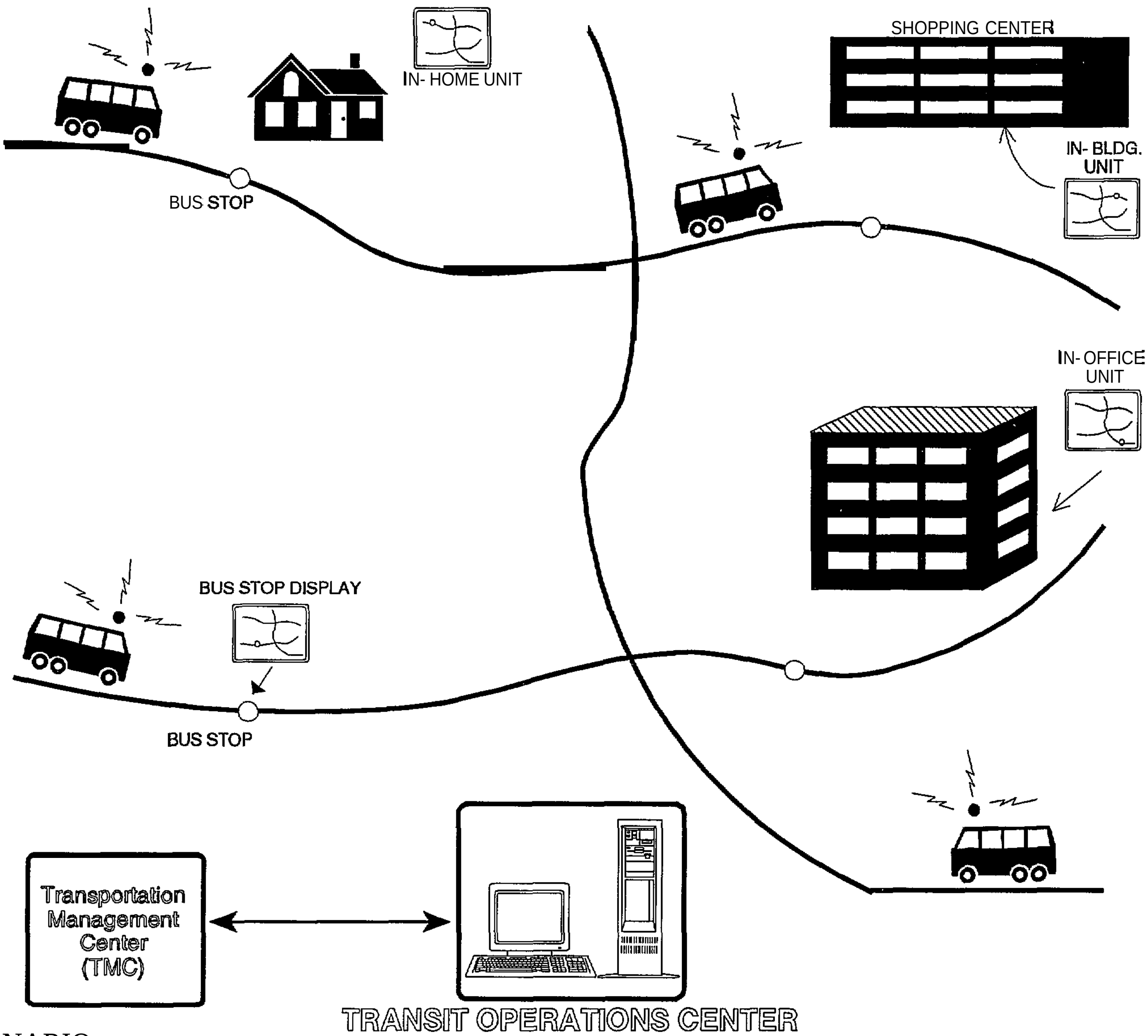
Table 1. Scenario 1. Route deviation dynamic stop requests and routing.

Summary Evaluation

Criteria Category	summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	An alternative to conventional point-point dial-a-ride services. Could also be used on conventional routes during the off-peak.
2. Technically Feasible?	YES	Limited systems have been tested. New technologies will address problems with these earlier systems.
3. Potential Benefits	HIGH	Reduced vehicle-miles/vehiclehours. Improved service to disabled without duplicate routes. Reduced operating costs during off-peak.
4. Potential Costs	MODERATE to HIGH	Costs for basic service should be moderate. Costs for deploying request and information units at stops could be high.
5. Institutional/Legal Barriers	FEW	Some jurisdictions may consider thii to be cab or charter service.
6. Financially Feasible?	YES	Similar system has been successfully demonstrated in Germany (FOCCS).
7. Attractiveness to Users, Operators, and Society	HIGH	Users should fmd service attractive. Will require operators to adjust to deviation services.
8. Human Factors Effectiveness	HIGH	Little training required. Information and call units should be user friendly.
9. Potential for Success	HIGH	Especially for providing ADA services.
10. Implementation Potential	HIGH	AVL and central dispatch must be in place prior to implementation.

SCENARIO NO. 2
REAL-TIME BUS POSITION AND ARRIVAL INFORMATION

GOAL: To facilitate transit use by providing real-time vehicle position information to users.



SCENARIO

1. Bus transmits real-time position information to Transit Operations Center.
2. Transit Operations Center transmits real-time location and arrival information to homes and businesses.
3. Users can alter schedules if bus is seriously delayed.

Figure 5. Real-time bus position and arrival information

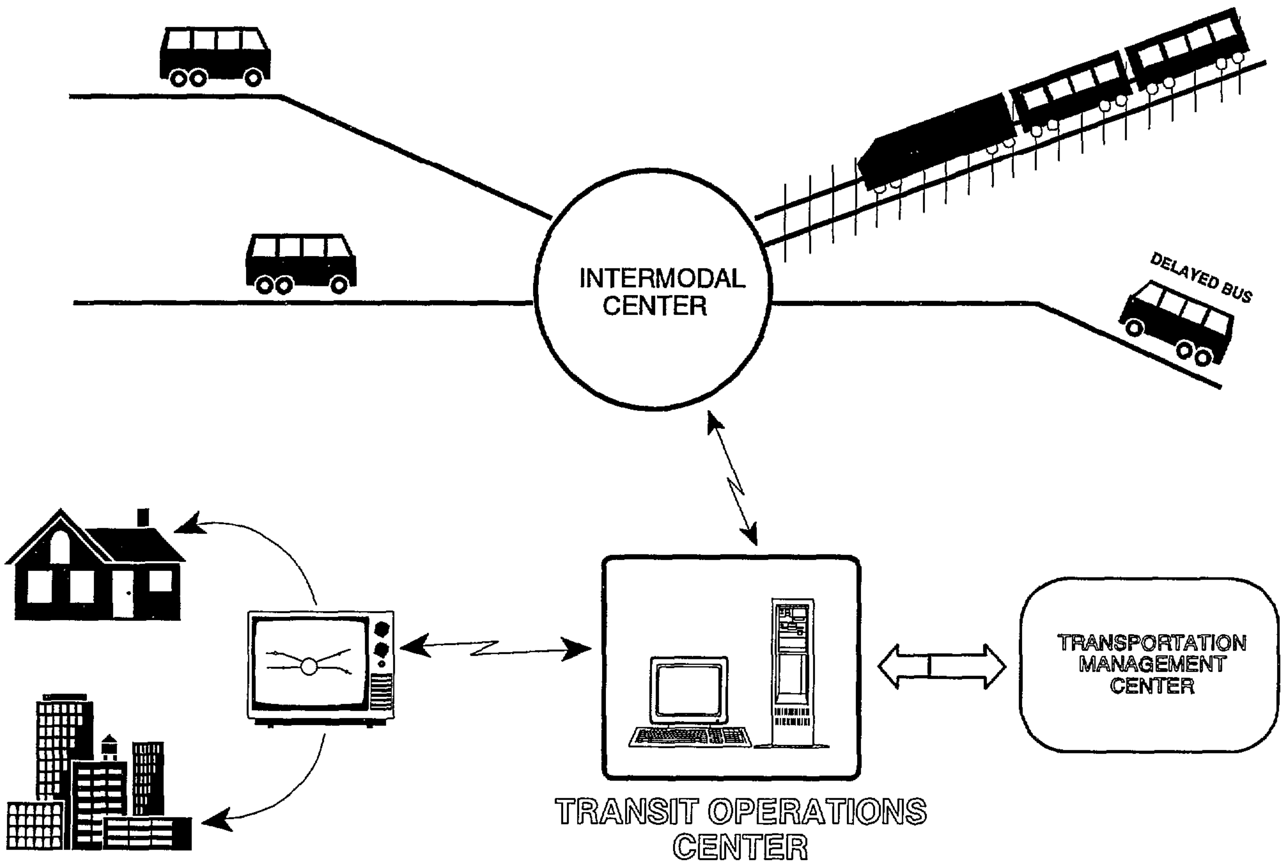
Table 2. Scenario 2. Real-time bus position and arrival information.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Provides better information to users of transit on the status of buses, trains, and transfer vehicles.
2. Technically Feasible?	YES	AVL is currently being implemented on many transit systems. This type of system has been operated in Ann Arbor, MI and Europe.
3. Potential Benefits	MODERATE	Reliable, current information could promote increased ridership by reducing uncertainty associated with transit use.
4. Potential Costs	MODERATE to HIGH	Depends on the number and type of information displays used.
5. Institutional/Legal Barriers	FEW	May require agreements with local cable TV companies and private owners for placement of terminals on private property.
6. Financially Feasible?	YES	Transmission to homes, businesses, and transit centers feasible. Cost of installing and maintaining on-street displays could be high.
7. Attractiveness to Users, Operators, and Society	HIGH to MODERATE	Users would find service attractive. Operators may see increased costs with little short term gain.
8. Human Factors Effectiveness	HIGH	Use of touch-screen and videotext displays should be easiest to use. Speech recognition technology emerging would make system more friendly and increase usage. Provision of hard-copy of travel plans would increase usefulness.
9. Potential for Success	HIGH	Operation of these systems has proven effective. Many agencies are now installing the AVL systems required for operation.
10. Implementation Potential	MODERATE	Many operators are currently not enthusiastic. Financial support may be required for installation.

SCENARIO NO. 3
INTERMODAL CENTER
TIMED TRANSFER MANAGEMENT

GOAL: Improve efficiency of timed transfer and intermodal transfer operations.



SCENARIO

1. Buses, trains, ferries, etc. transmit location data to the intermodal transfer center.
2. The system monitors vehicle status, eliminating the need to allot slack time in the schedules.
3. System updates schedules and transmits real-time data to homes and workplaces.
4. System can attempt to "speed up" delayed vehicles or hold on-time vehicles to ensure proper passenger transfers.

Figure 6. Intermodal center timed transfer management.

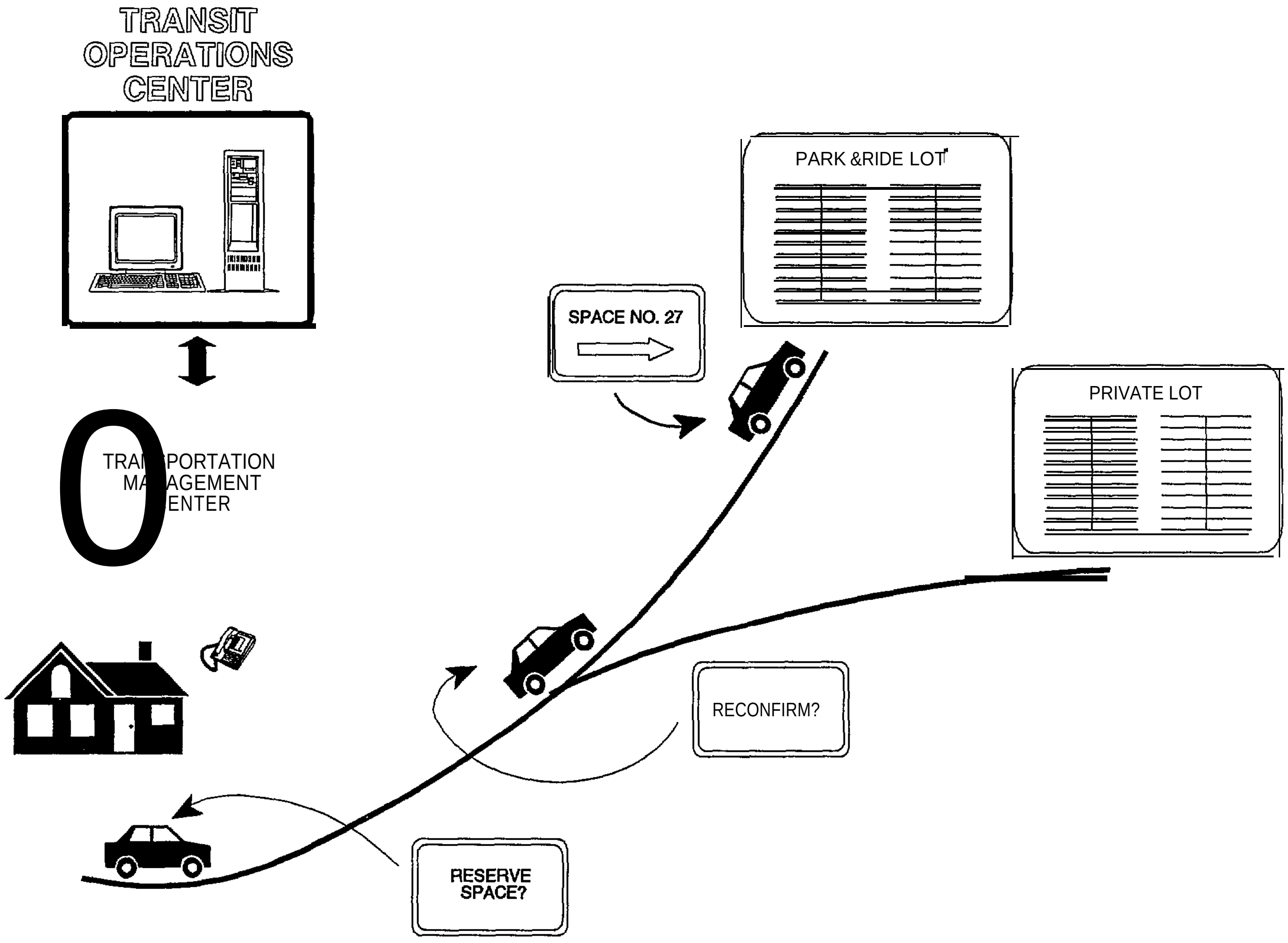
Table 3. Scenario 3. Intermodal center timed transfer management.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Facilitates schedule coordination and real-time response to traffic and operating conditions.
2. Technically Feasible?	YES	Is presently done using radio dispatch systems.
3. Potential Benefits	HIGH	Reduced travel time and enhanced reliability for transit riders. Potential for reducing scheduled vehicle hours.
4. Potential Costs	LOW	Little additional equipment required if AVL system already in place.
5. Institutional/Legal Barriers	FEW	Would require a link with the local TMC and possibly cable TV outlets for updated schedule information.
6. Financially Feasible?	**YES**	Would not require any additional funding on the part of the transit **agency if AVL in place.**
7. Attractiveness to Users, Operators, and Society	**HIGH**	**Increases user confidence and security in transfer system. Permits operators to reliably provide transfers and reduce slack time in schedules.**
8. Human Factors Effectiveness	HIGH	Little operator training required. No behavioral changes necessary for users. Information displays should be clear.
9. Potential for Success	HIGH	Operating principle has already been demonstrated using existing technology.
10. Implementation Potential	HIGH	Many transit agencies are currently installing AVL systems. This is an effective use of its capabilities at a low implementation cost.

SCENARIO NO. 4
TRANSIT PARKING
INFORMATION AND SPACE RESERVATION

GOAL: Encourage the use of transit by reducing the uncertainty associated with finding a parking space.



SCENARIO

1. Driver queries system for parking availability from home or in-vehicle ATIS unit.
2. User reserves space at park & ride. If user-does not arrive in allotted time, driver is asked to reconfirm.
3. Upon arrival driver verifies reservation and pays parking fee using transit smart card.

Figure 7. Transit parking information and space reservation.

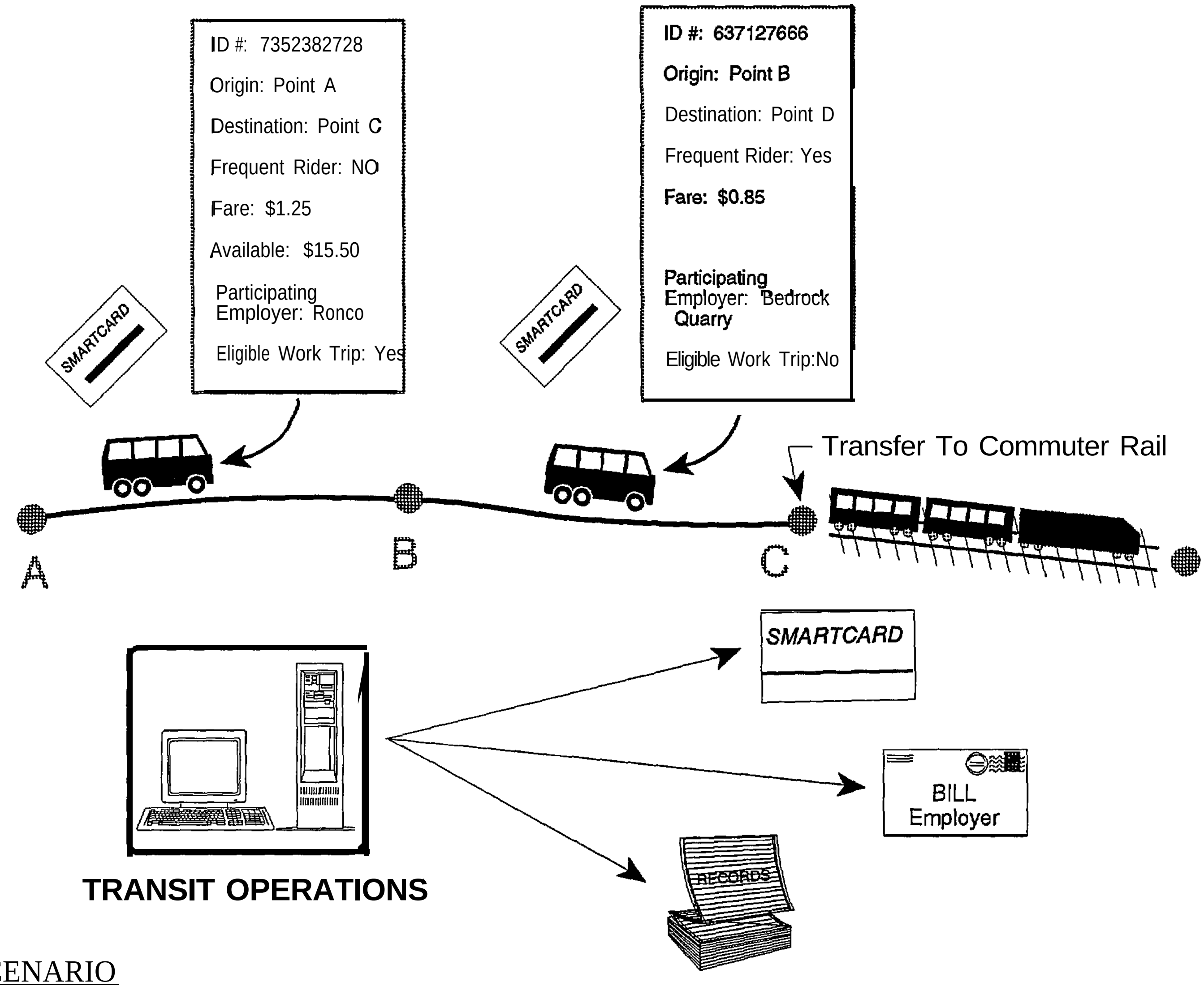
Table 4. Scenario 4. Transit parking information and space reservation.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Goal is to increase transit use. It is a true "management" strategy since drivers can be directed to under-used facilities.
2. Technically Feasible?	YES	Basic system could use a reservation system similar to those currently used by the airline industry.
3. Potential Benefits	LOW to MODERATE	Applicable only in urban areas with park-ride transit systems and park-ride lots where demand exceeds capacity.
4. Potential Costs	LOW to MODERATE	If integrated into existing transit information systems, additional costs could be low.
5. Institutional/Legal Barriers	LOW	Operators would need to be able to charge a fee for spaces reserved but not used.
6. Financially Feasible?	YES	User fees could most likely cover the costs of installation and operation.
7. Attractiveness to Users, Operators, and Society	MODERATE	High for users and potentially high for operators. Some current users may feel that "first-comefnst-served" is more equitable.
8. Human Factors Effectiveness	HIGH	Should be high. Could be similar to many existing trip reservation systems. User confidence will be important.
9. Potential for Success	MODERATE	Should be high in appropriate areas. Would be lower in areas where parking problems are less acute.
10. Implementation Potential	MODERATE	A fairly low cost means of alleviating some of the user doubt associated with using park-ride transit.

SCENARIO NO. 5
SMARTCARD FARE COLLECTION

GOAL: To unify multi-modal fare collection and increase ridership through a coordinated fare management system that allows discounts for frequent riders and facilitates employer-subsidized transit use.



SCENARIO

1. A bus, taxi, or train uses an in-vehicle "Smartcard Reader" to record/collect fares from riders.
2. The "Smartcard Reader" accurately allocates fare-s based on distances or destination.
3. The system rewards frequent riders with discounts while others pay no more than the cash fare.
4. All fare data is recorded on-board downloaded at the Transit Operations Center for automated billing.
5. Fare structure of participating transit providers is coordinated and integrated.
6. Participating employers are billed only for eligible work trips.

Figure 8. Smartcard fare collection.

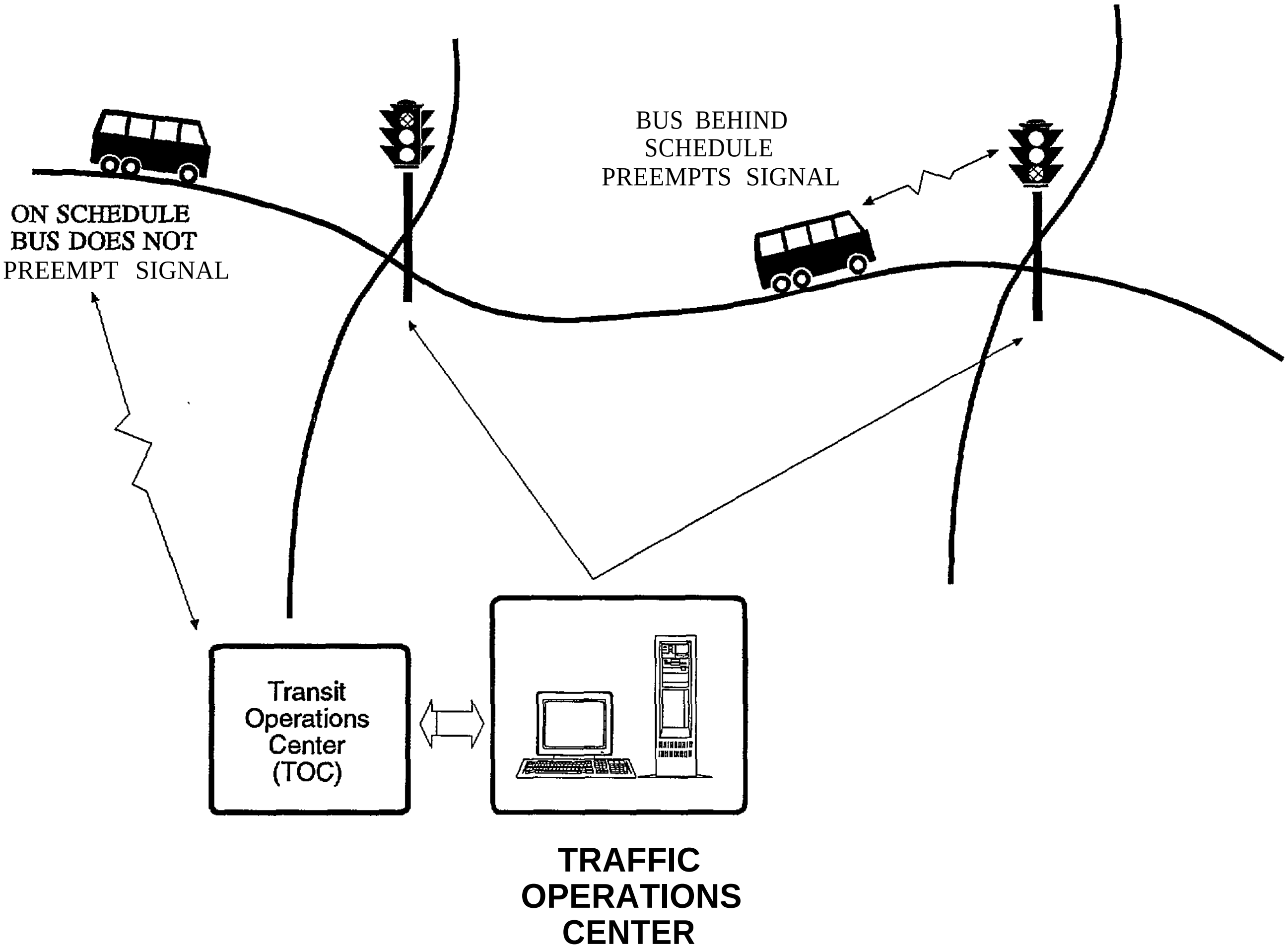
Table 5. Scenario 5. Smartcard fare collection.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	**YES**	Will facilitate travel and fare collection across different modes of transit.
2. Technically Feasible?	**YES**	Limited systems have been successfully operated in Europe and Japan.
3. Potential Benefits	MODERATE/HIGH	Would simplify fare payment, facilitate transit subsidies allow easier travel between modes, permit distance based fares, and possibly increase ridership.
4. Potential Costa	MODERATE	Would require smartcard readers on all vehicles. Smartcards themselves would be more expensive than traditional fare media.
5. Institutional/Legal Barriers	MODERATE	Will require cooperation among transit agencies if used in a multi-operator environment. Privacy also an issue.
6. Financially Feasible?	**YES**	Operating costs could be lowered.
7. Attractiveness to Users, Operators, and Society	HIGH	Benefits users, operators, and society.
8. Human Factors Effectiveness	HIGH	Should be easier to use than current cash payment methods. User acceptance has been demonstrated to be high.
9. Potential for Success	HIGH	Several test programs have been very successful.
10. Implementation Potential	HIGH	Smartcards will have applications throughout the transportation industrv (e.g.. transit fares, tolls, road pricing).

SCENARIO NO. 6
TRANSIT/HOV PRIORITY ON ROADWAY NETWORK

GOAL: Use responsive signal systems to give priority to the movement of people rather than vehicles.



SCENARIO

1. Traffic Operations Center receives real-time traffic data from traffic sensors and transit data from the transit operations center.

2. Control unit optimizes signal timings giving priority to transit and HOV vehicles.

3. On-board signal pre-emption units allow buses behind schedule to gain time. Units would not pre-empt if bus was on or ahead of schedule.

Figure 9. Transit/HOV priority on roadway network.

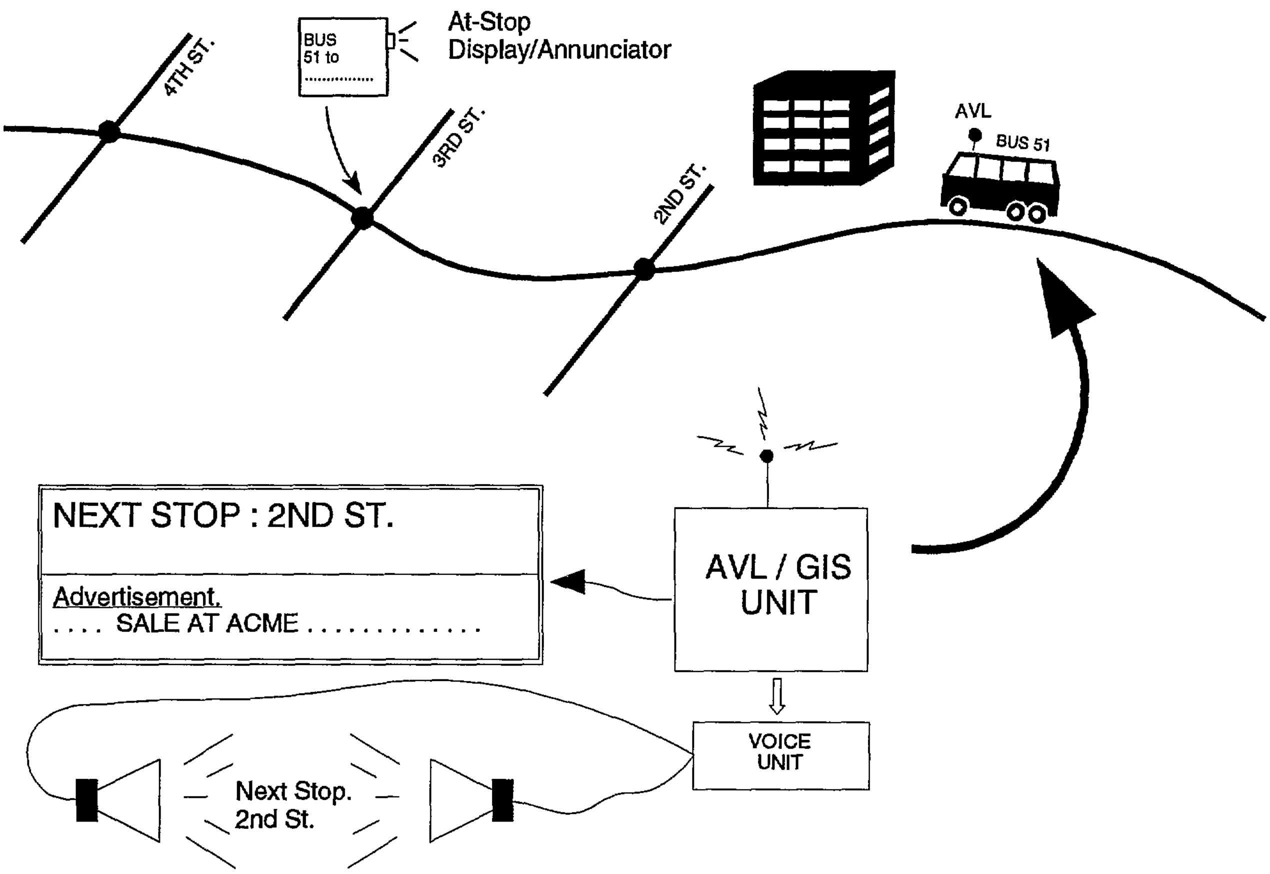
Table 6. Scenario 6. Transit priority on roadway networks.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would optimize signal timings for the movement of people by giving priority to transit and HOV vehicles.
2. Technically Feasible?	YES	Could use transit AVL and traffic monitoring data to provide network-wide control.
3. Potential Benefits	MODERATE	Improved transit schedule reliability and attractiveness to users during normal conditions and incidents.
4. Potential Costs	LOW	Implementation costs could be low if operated in a mature IVHS environment with existing AVL and signal control systems.
5. Institutional/Legal Barriers	MODERATE to HIGH	Maintaining transit priority under all conditions may be a policy decision that will have to be agreed on by the actors involved.
6. Financially Feasible?	YES	Could be integrated into existing signal control system.
7. Attractiveness to Users, Operators, and Society	HIGH/ LOW	Very attractive to transit users and operators, much less so to auto drivers who may be adversely impacted.
8. Human Factors Effectiveness	HIGH	Operation should be largely automated, with little human input required.
9. Potential for Success	MODERATE	Will require policy commitments from transportation agencies involved to insure success.
10. Implementation Potential	MODERATE	Most likely in arcas where transit AVL and advanced signal control equipment are in place.

SCENARIO NO. 7
TRANSIT VEHICLE INFORMATION DISPLAYS

GOAL: Provide vehicle location information to passengers on transit vehicles, including blind and hearing impaired riders.



SCENARIO

1. AVL System on train or bus monitors vehicle location along the transit route.
2. Variable signs display next stop and status of connecting routes. Voice Synthesis Unit automatically announces each stop/intersection.
3. To earn extra revenue, system may also display advertisements for businesses along theroute.
4. Alternatively, system could transmit stop information over short-range FM signals for riders with special radio units.

Figure 10. Transit vehicle information displays.

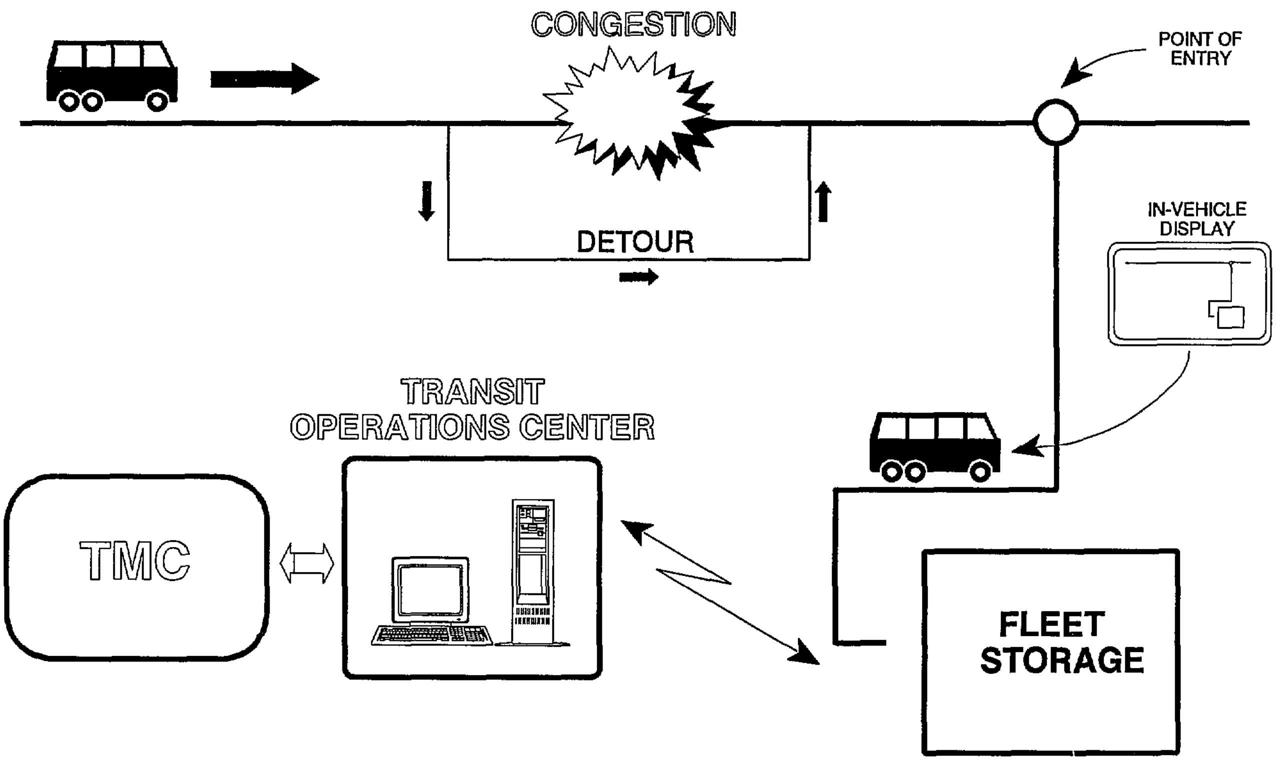
Table 7. Scenario 7. Transit vehicle information displays.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Will provide on-board audio and visual location and schedule information to disabled as well as non-disabled passengers.
2. Technically Feasible?	**YES**	Some basic systems have been tested in Europe and North America.
3. Potential Benefits	YES	Ease transit use for disabled. Provide up to the minute information to all passengers in seeking unfamiliar stops.
4. Potential Costs	MODERATE to HIGH	Assuming AVL and ATIS systems are already in place, cost of these systems may be moderate, although current costs are high.
5. Institutional/Legal Barriers	FEW	Institutional requirements may mandate the use of these systems.
6. Financially Feasible?	YES	Information signs could also display advertisements to offset cost of installation.
7. Attractiveness to Users, Operators, and Society	MODERATE	User response to test programs has been positive. Some operators may feel that these are an expensive luxury.
8. Human Factors Effectiveness	HIGH	Should make bus transit more user friendly. Automation will relieve drivers of these duties.
9. Potential for Success	HIGH	Initial tests of more limited systems have been successful.
10. Implementation Potential	HIGH	Transit operators will need to implement some type of systems to meet ADA requirements.

SCENARIO NO. 8
TRANSIT SCHEDULE RELIABILITY

GOAL: Improve transit schedule reliability in congested areas.



SCENARIO

1. Real-time road and traffic conditions are monitored in a transit operations center.
2. Information is synthesized and potential delays and disruptions in service are predicted.
3. Additional buses are dispatched and directed to the point and time to enter service.
4. Alternatively, dispatchers could reroute buses or implement signal pre-emption plans to maintain schedules.

Figure 11. Transit schedule reliability.

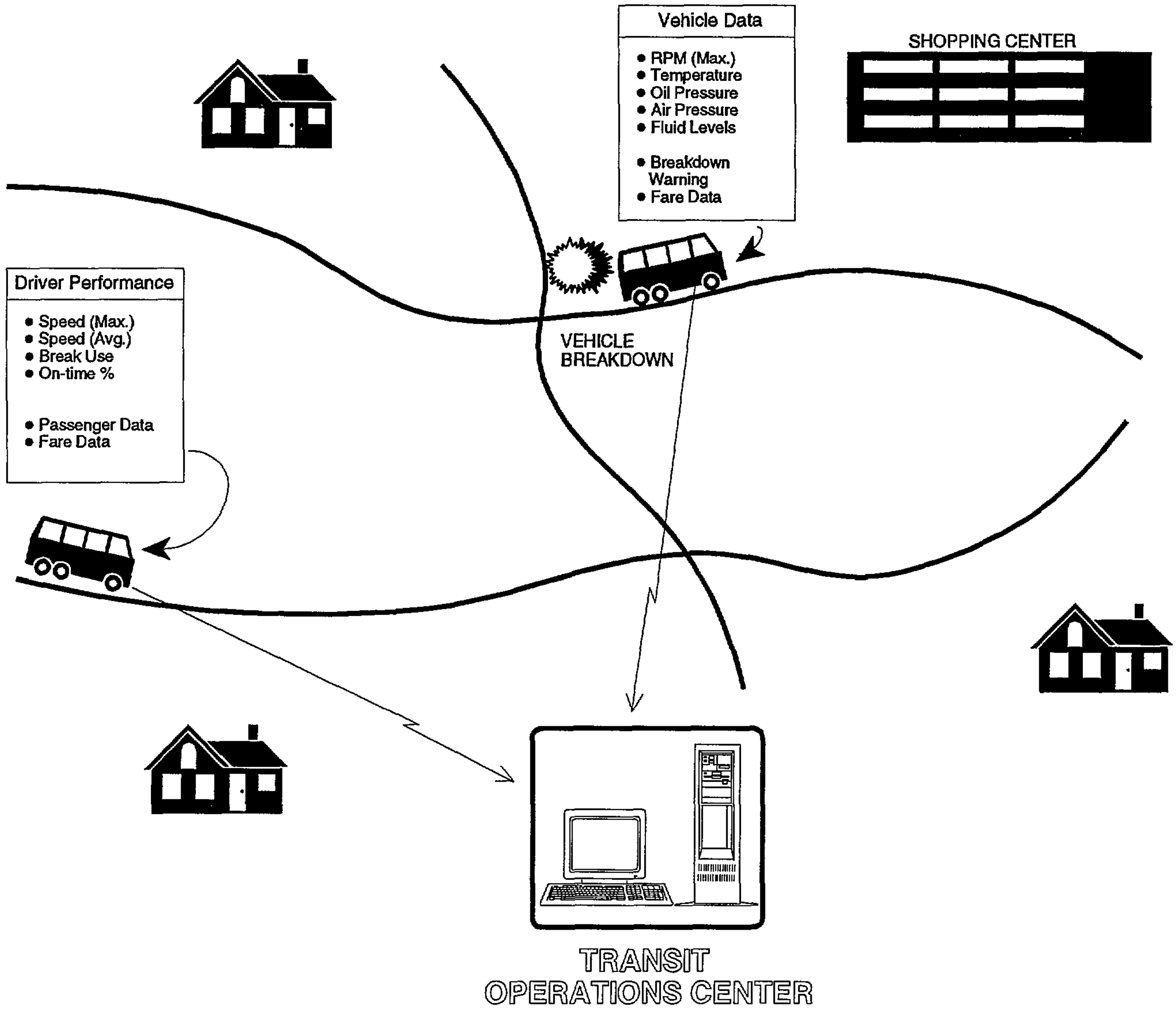
Table 8. Scenario 8. Transit schedule reliability.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would allow managers to maintain schedule reliability and, in theory, provide additional vehicles in response to congestion.
2. Technically Feasible?	YES	Vehicle location and dispatching can be done with existing AVL systems. Predictive modeling will require cooperation with ATMS.
, 3. Potential Benefits	MODERATE-LOW	Reduced delays and less crowding for transit users. Increased reliability could attract some additional transit riders.
4. Potential Costs	MODERATE per unit; HIGH for system	Cost for basic monitoring and forecasting system would be relatively low. Cost for maintaining stand-by vehicles would be high.
5. Institutional/Legal Barriers	FEW	Could require negotiating labor agreement to pay lower wages for stand-by service.
6. Financially Feasible?	DIFFICULT	Basic schedule maintenance system would be feasible. Stand-by bus dispatching might prove impractical for many systems.
7. Attractiveness to Users, Operators, and Society	HIGH/LOW	Provides tangible benefits to users. May also be attractive to operators for limited applications.
8. Human Factors Effectiveness	HIGH	No learning or behavioral changes required on the part of users or operators.
9. Potential for Success	HIGH/LOW	High for basic headway maintenance system, moderate for limited use vehicle stand-by system, low for area-wide implementation.
10. Implementation Potential	MODERATE	Could be easily done if extra funding was available. Liiited implementation on a few congested routes may be most practical.

SCENARIO NO. 9
IMPROVED TRANSIT MANAGEMENT INFORMATION

GOAL: Increase transit efficiency by monitoring vehicle condition and driver performance.



SCENARIO

1. Driver performance data are transmitted to the Transit Operations Center and also recorded on-board.
2. Vehicle condition and AVL data are used to alert supervisors to potential problems in real time.
3. Service vehicles and an additional bus can be dispatched to the scene of a breakdown.

Figure 12. Improved transit management information.

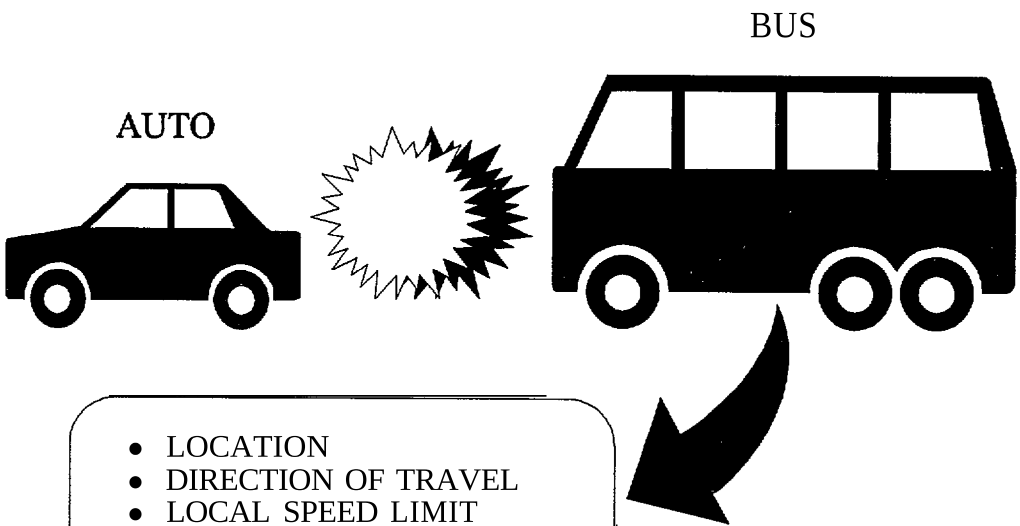
Table 9. Scenario 9. Improved transit management information.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would allow transit operators to more closely monitor vehicle and driver performance.
2. Technically Feasible?	YES	Elements of this system are being introduced into vehicles today. These systems have also been presented as part of the "Smartbus.
3. Potential Benefits	HIGH	Could result in reduced maintenance costs and improved system reliability. Also would allow operators to detect poor driving behavior and correct via counseling or training.
4. Potential Costs	MODERATE	Would require on-board sensors and computers, equipment to download the data, and software to analyze the data.
5. Institutional/Legal Barriers	LOW	Some drivers and unions may object to having equipment that monitors driver performance.
6. Financially Feasible?	YES	Benefits should exceed installation and operating costs.
7. Attractiveness to Users, Operators, and Society	MODERATE	Make transit use more attractive by reducing poor driver behavior. Main attraction would be for system operators. Some may feel that drivers can adequately monitor vehicle performance.
8. Human Factors Effectiveness	HIGH	Little training needed. Automated systems could monitor more data than human operators can.
9. Potential for Success	HIGH	There is a demonstrated need for improved maintenance and monitoring systems.
10. Implementation Potential	**YES**	Potential for reduced operating costs will make implementation likely.

SCENARIO NO. 10
ACCIDENT DATA RECORDING SYSTEM

GOAL: Facilitate accident investigations and reduce false accident claims against transit operators.



- LOCATION
- DIRECTION OF TRAVEL
- LOCAL SPEED LIMIT
- VEHICLE SPEED
- DRIVER PERFORMANCE
- PASSENGER COUNT
- PASSENGER ID
- AUTOMATIC NOTIFICATION

SCENARIO

1. Vehicle performance monitoring equipment and smartcard reader could be used to record data at time of an accident.
2. System would automatically notify authorities and provide location information.
3. Time, vehicle speed, direction, and operator performance could be used to analyze accidents.
4. Similar systems could be applied to private trucks and autos to aid police in accident investigations.

Figure 13. Accident data recording system.

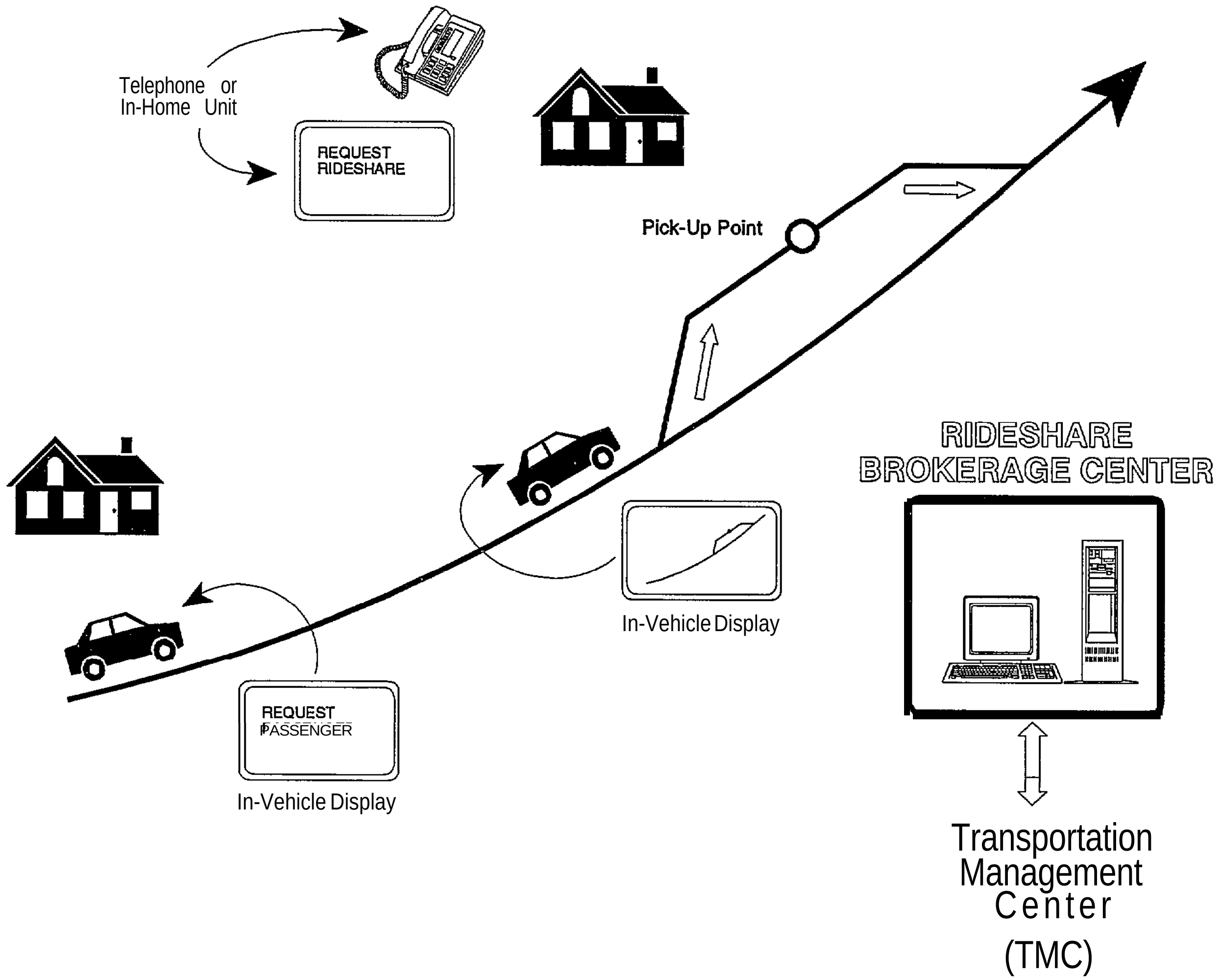
Table 10. Scenario 10. Accident data recording system.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would help to reduce operating and liability cost of transit.
2. Technically Feasible?	YES	Many of monitoring systems needed are being developed for other uses.
3. Potential Benefits	LOW to MODERATE	Could reduce fraudulent accident claims and liability costs. Operational testing needed to determine actual benefits.
4. Potential Costs	LOW to HIGH	Installation costs low if AVL and vehicle performance monitoring equipment already present. Potentially high if not.
5. Institutional/Legal Barriers	MODERATE	Passenger identification recording equipment may raise questions of privacy.
6. Financially Feasible?	UNCERTAIN	Financial feasibility will need to be determined in operational testing.
7. Attractiveness to Users, Operators, and Society	MODERATE	Would be very attractive to transit operators if it could significantly reduce fraudulent claims.
8. Human Factors Effectiveness	HIGH	No behavior modification required.
9. Potential for Success	LOW to MODERATE	Vehicle monitoring functions fairly easy to perform. Recording passenger identities more uncertain.
10. Implementation Potential	MODERATE	Cost benefits will have to be clearly demonstrated before operators likely to implement.

SCENARIO NO. 11
REAL TIME RIDESHARING

GOAL: Increase rideshare/HOV usage by allowing for real time rideshare matching and in-vehicle route guidance.



SCENARIO

1. Driver seeking rider enters request into system. Person seeking ride enters request and destination.
2. System matches rider with drivers to same destination and "offers" rider to nearest driver.
3. Confirmation of pick-up is made by both parties. Fees could be automatically billed and credited so that no money changes hands.

Figure 14. Real-time ridesharing.

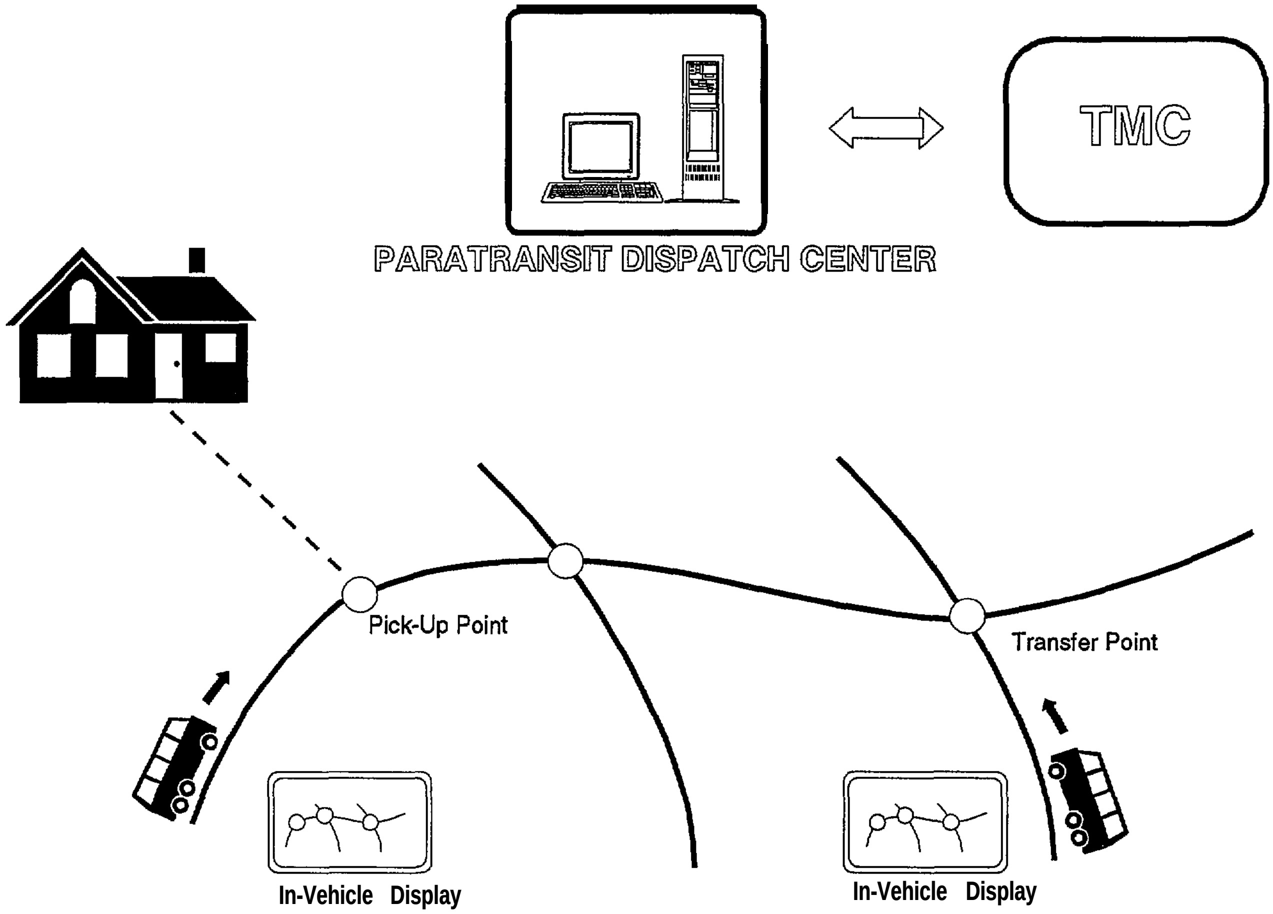
Table 11. Scenario 11. Real-time ridesharing.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Goal is to increase HOV/rideshare usage.
2. Technically Feasible?	YES	All basic technology exists today. System could be upgraded as new technologies become available.
3. Potential Benefits	HIGH	Reductions in SOV trips, improved mobility for system users, a low cost alternative to conventional transit, air quality applications.
4. Potential Costs	MODERATE	Requires computer brokerage center. Operating costs should be moderate. User fees should be attractive to riders and drivers.
5. Institutional/Legal Barriers	MODERATE	User safety and operator liability would be major concerns. Could be overcome with security measures. Licensing may be required.
6. Financially Feasible?	YES	Some operator subsidies would be required. These could be generated through tolls, parking, and other transportation fees.
7. Attractiveness to Users, Operators, and Society	HIGH	Potentially high user and societal attractiveness. Could also be attractive to operators of existing transit and paratransit systems.
8. Human Factors Effectiveness	MODERATE	System should be fairly easy to use. Key element will be establishing a levels of reliability, user comfort, and security.
9. Potential for Success	HIGH	Incentives need to be clearly defmed for each user group.
10. Implementation Potential	HIGH	A relatively simple, low-cost means of reducing congestion and improving mobility in lower density areas.

SCENARIO NO. 12
PARATRANSIT DISPATCHING

GOAL: improve the productivity of paratransit sytems.



SCENARIO

1. User enters paratransit request stating pick-up point and arrival times, and destination.
2. The system selects a vehicle and optimizes its routing based on real-time travel information.
3. System coordinates transfers with other transit or paratransit vehicles.
4. User is notified of bus status and given times for pick-up, transfer, and arrival at the destination.
5. Bus driver is given new routing and guided to pick-up point and destination by in-vehicle ATIS.

Figure 15. Paratransit dispatching.

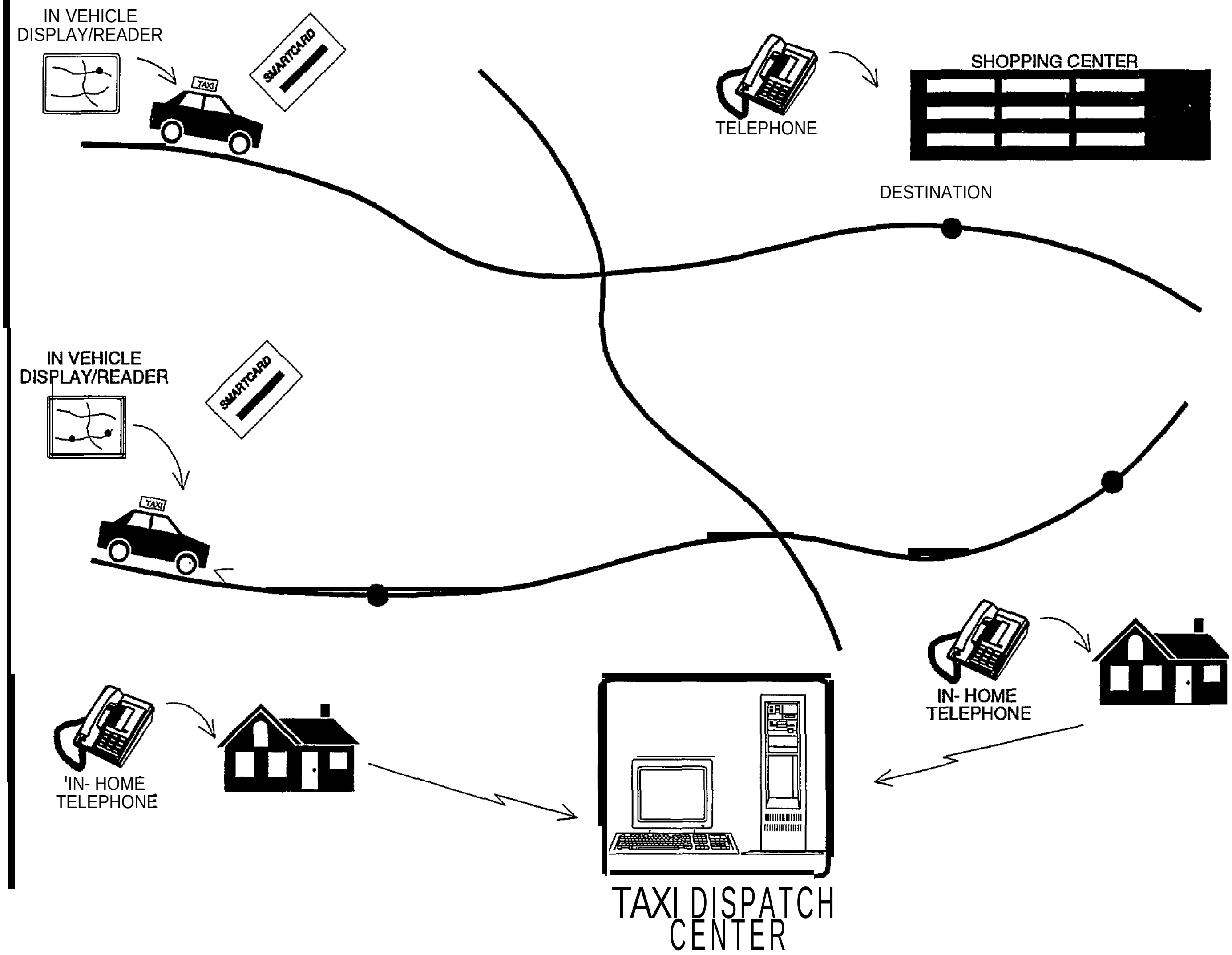
Table 12. Scenario 12. Paratransit dispatching.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	**YES**	Permits more effective dial-a-ride in rural and suburban areas. Could enhance use of private carriers through coordination.
2. Technically Feasible?	YES	Certain elements of the system are already in use in taxi and courier fleets.
3. Potential Benefits	HIGH	More flexible service for users. Service could be provided with fewer vehicles, driver hours, and vehicle miles.
4. Potenlial Costs	MODERATE	All vehicles and dispatch center must be equipped with AVL and ATIS systems for maximum effectiveness.
5. Institutional/Legal Barriers	MODERATE	May compete with local taxi services. Should seek to integrate taxis into paratransit service.
6. Financially Feasible?	YES	Could lead to reduced operating costs. May have funding difficulties if it compete with private services.
7. Attractiveness to Users, Operators, and Society	HIGH	More flexible service for users, more efficient service for operators, improved mobility in rural and suburban areas.
8. Human Factors Effectiveness	HIGH	Some driver traініig needed. Riders could use manual or automated phone reservation system.
9. Potential for Success	HIGH	These types of systems are already in use. Improvements would benefit users and operators.
10. Implementation Potential	HIGH	Moderate cost for significant benefit. Could be implemented as an upgrade to existing systems.

SCENARIO NO. 13
TAXI MANAGEMENT/USER-SIDE SUBSIDY WITH SMARTCARDS

GOAL: Increase user-side subsidy service calls through improved taxi dispatch management efficiency.



SCENARIO

1. Ride requests are made to the Taxi dispatch center and vehicle is dispatched to location.
2. Upon dispatching, vehicle information is recorded. Smartcard is used for payment.
3. At end of shift, user-side subsidy information is downloaded for automated billing.

Figure 16. Taxi management/user-side subsidy with smartcards.

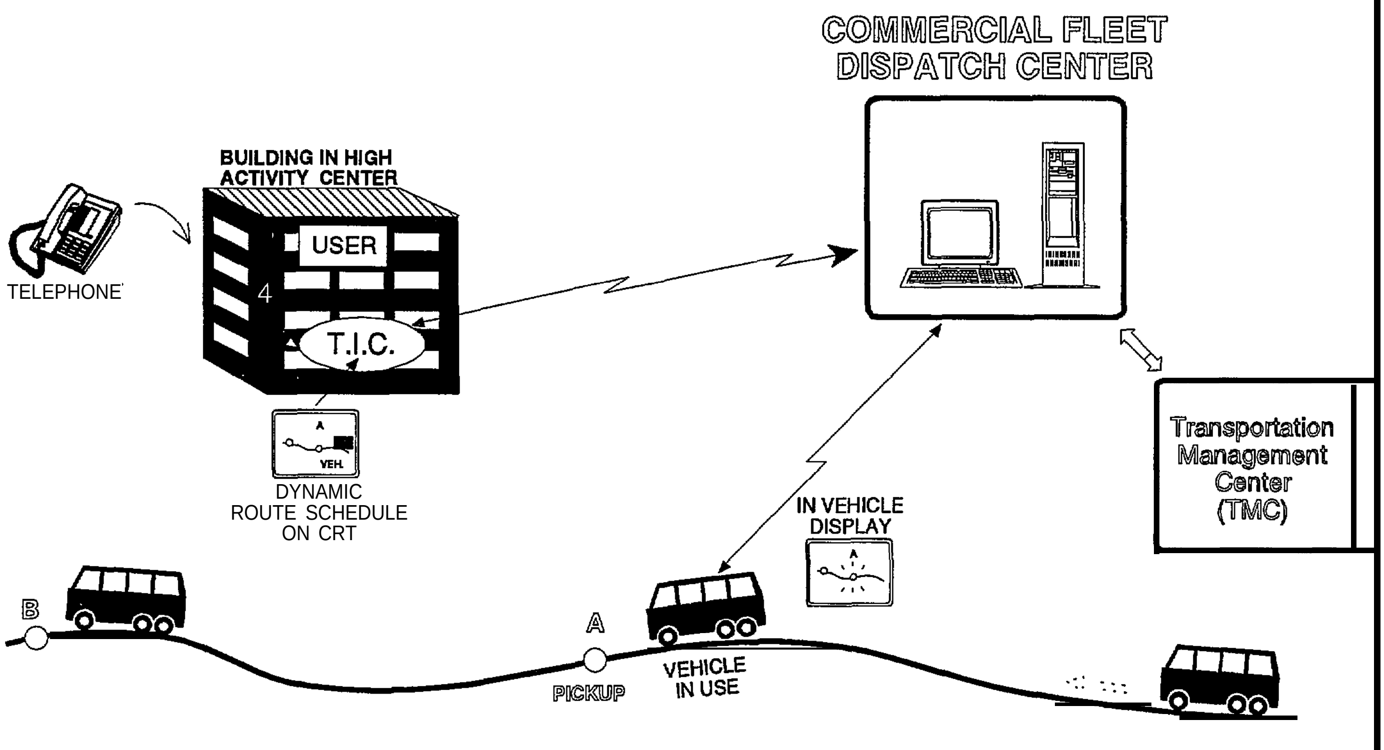
Table 13. Scenario 13. Taxi management/
user-side subsidy with smartcards.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable tc MM Transportation Management7	YES	Would facilitate market oriented approaches to providing transit service in both urban and rural areas.
2. Technically Feasible?	YES	Could be done with existing technologies.
3. Potential Benefits	MODERATE	Would simplify fare payment, automate billing, and reduce potential for fraud in user-side subsidy systems.
4. Potential Costs	MODERATE	In-vehicle reading and billing equipment required. Users would need smart cards, which may be expensive for low-income users.
5. Institutional/Legal Barriers	MODERATE	Public/private sector cooperation required. Could be some privacy issues.
6. Financially Feasible?	YES	Should yield benefits exceeding costs. May require some revenue guarantees to cover implementation costs.
7. Attractiveness to Users, Operators, and Society	HIGH	Automated billing beneficial to all. Reduced fraud benefits public. Some small taxi operators may find system costly to implement.
8. Human Factors Effectiveness	HIGH	Should make system much easier to use without the need for training or behavior modification.
9. Potential for Success	HIGH	The need for improved payment methods, automated billing, and fraud prevention has been demonstrated.
10. Implementation Potential	HIGH	Would prove useful in providing service to the elderly, disabled, and low-income users as well as transportation in rural areas.

SCENARIO NO. 14
URBAN GOODS AND PASSENGER MOVEMENT

GOAL: Use existing courier vehicles to also transport passengers in high activity centers.



SCENARIO

1. User requests ride by phone and enters origin and destination.
2. Operations center scans vehicles in use, assigns vehicle, and guides driver to pick-up point.
3. User monitors vehicle status on video screen in building.
4. User is picked up and trip data is recorded on-board.

Figure 17. Urban goods and passenger movement.

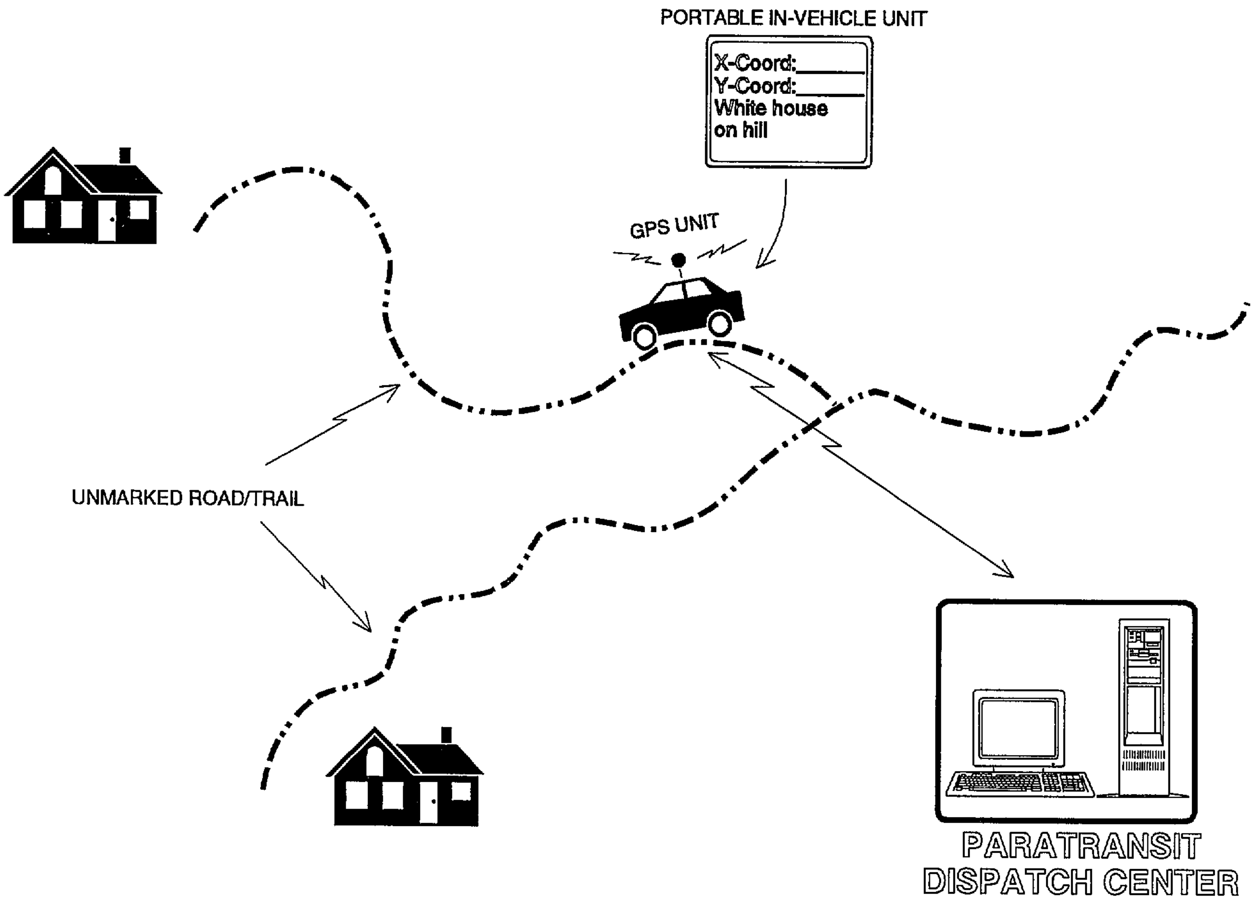
Table 14. Scenario 14. Urban goods and passenger movement.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would combine the movement of people and goods in urban and suburban high activity centers.
2. Technically Feasible?	YES	Courier services currently dispatch vehicles to pick up packages. Improved routing software could be used to transport people.
3. Potential Benefits	MODERATE	Would improve mobility and reduce VMT in high activity centers. Could result in increased revenue for operators.
4. Potential Costs	MODERATE to HIGH	Would require vehicles to be modified to carry passengers. Would increase operating and liability costs for operators.
5. Institutional/Legal Barriers	MODERATE	Might require changes in laws to permit courier vehicles to carry passengers. May face opposition from taxi and transit operators.
6. Financially Feasible7	UNCERTAIN	Will need operational test to determine ultimate feasibility. Funding will most likely have to come from private sector.
7. Attractiveness to Users, Operators, and Society	MODERATE to HIGH	If widely used, could provide tangible benefits to all parties.
8. Human Factors Effectiveness	HIGH	Should be fairly easy to use for passengers. Dispatching systems used to move packages could be modified to move people.
9. Potential for Success	MODERATE	Will require large enough pool of users to offset start-up and operating costs.
10. Implementation Potential	MODERATE	Will require a strong commitment from the private sector and local transportation agencies to implement.

SCENARIO NO. 15
RURAL ATIS/ROUTE GUIDANCE SYSTEM

GOAL: Provide route guidance for rural paratransit, volunteer ride services, and emergency services.



SCENARIO

1. Persons in rural area request rides via telephone.
2. Volunteer ride service vehicles are equipped with portable ATIS Systems that can be transferred between vehicles.
3. On-board guidance system provides description of house, landmarks, and optimum approach.
4. System would also be useful for emergency services.

Figure 18. Rural ATIS/route guidance system.

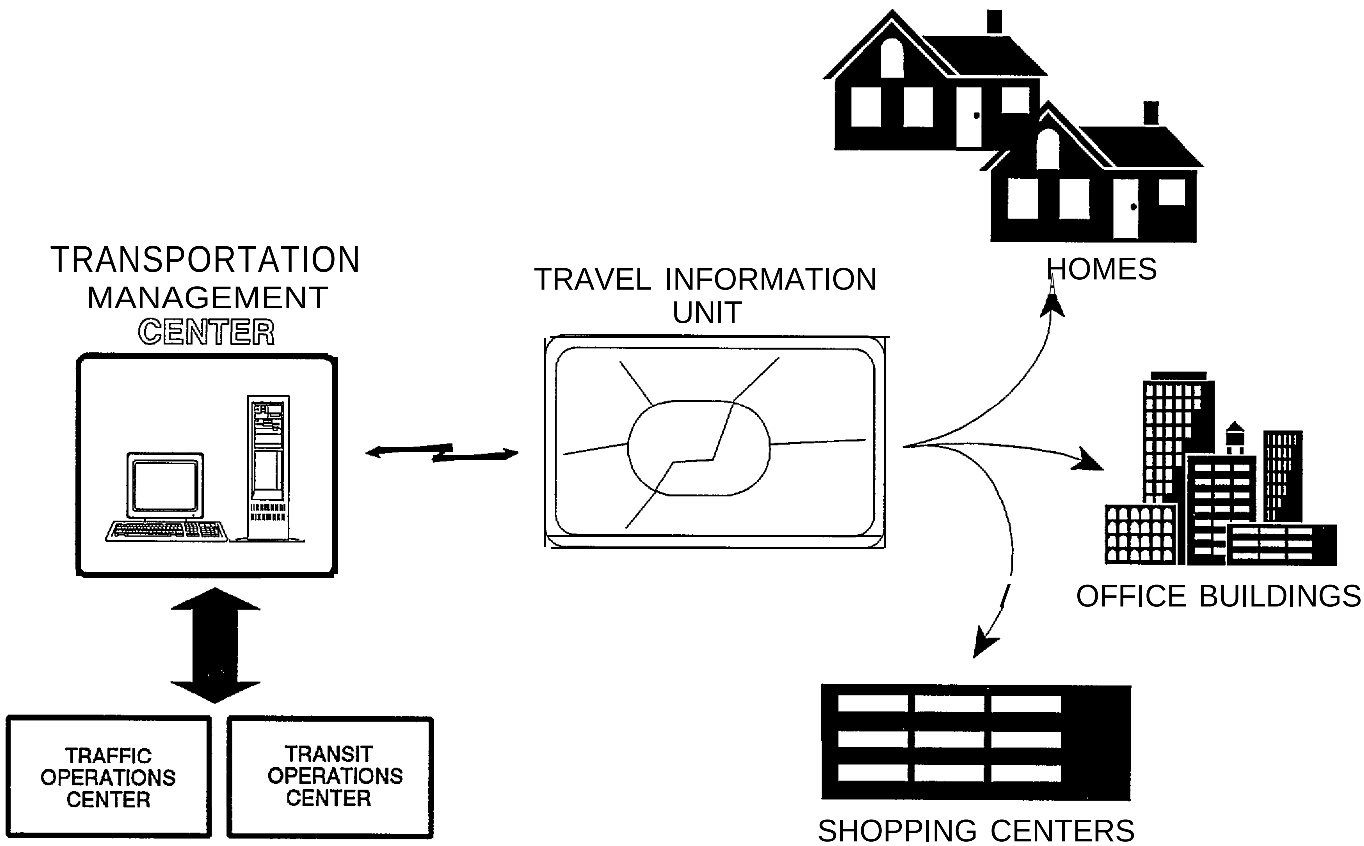
Table 15. Scenario 15. Rural ATIS/route guidance system.

General Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	**YES**	Would improve rural transit and paratransit services.
2. Technically Feasible?	YES	Would utilize AVL, ATIS, and GIS-type technologies.
3. Potential Benefits	MODERATE	Would provide route guidance and pick-up point location for drivers in rural transit services.
4. Potential Costs	MODERATE	Would require equipping vehicles with route guidance units and possibly creating a GIS data base for the service area.
5. Institutional/Legal Barriers	FEW	There would be few, if any, institutional or legal barriers.
6. Financially Feasible?	YES	Cost of creating rural data bases could be beyond means of many agencies. May require government funding for implementation.
7. Attractiveness to Users, Operators, and Society	HIGH	Should be attractive to both users and operators of rural transit and paratransit services.
8. Human Factors Effectiveness	HIGH	Rural mute guidance may require more complex instructions than urban guidance. New display formats may need to be examined.
9. Potential for Success	MODERATE	Will address a real problem in rural transit services, but may have a limited market.
10. Implementation Potential	HIGH	Start-up costs could be high if databases need to be created. May require government funding to implement.

SCENARIO NO. 16
REAL-TIME TRANSPORTATION INFORMATION AT HOMES, WORKPLACES, AND STORES

GOAL: Facilitate decisions by travelers by providing real-time information on travel conditions.



SCENARIO

1. Transportation Management Center broadcasts real-time information on roadway and transit conditions.
2. Information units would be available at homes, shopping areas, and office buildings.
3. Information permits workers and shoppers to alter travel plans if necessary.

Figure 19. Real-time transportation information at homes, workplaces, and stores.

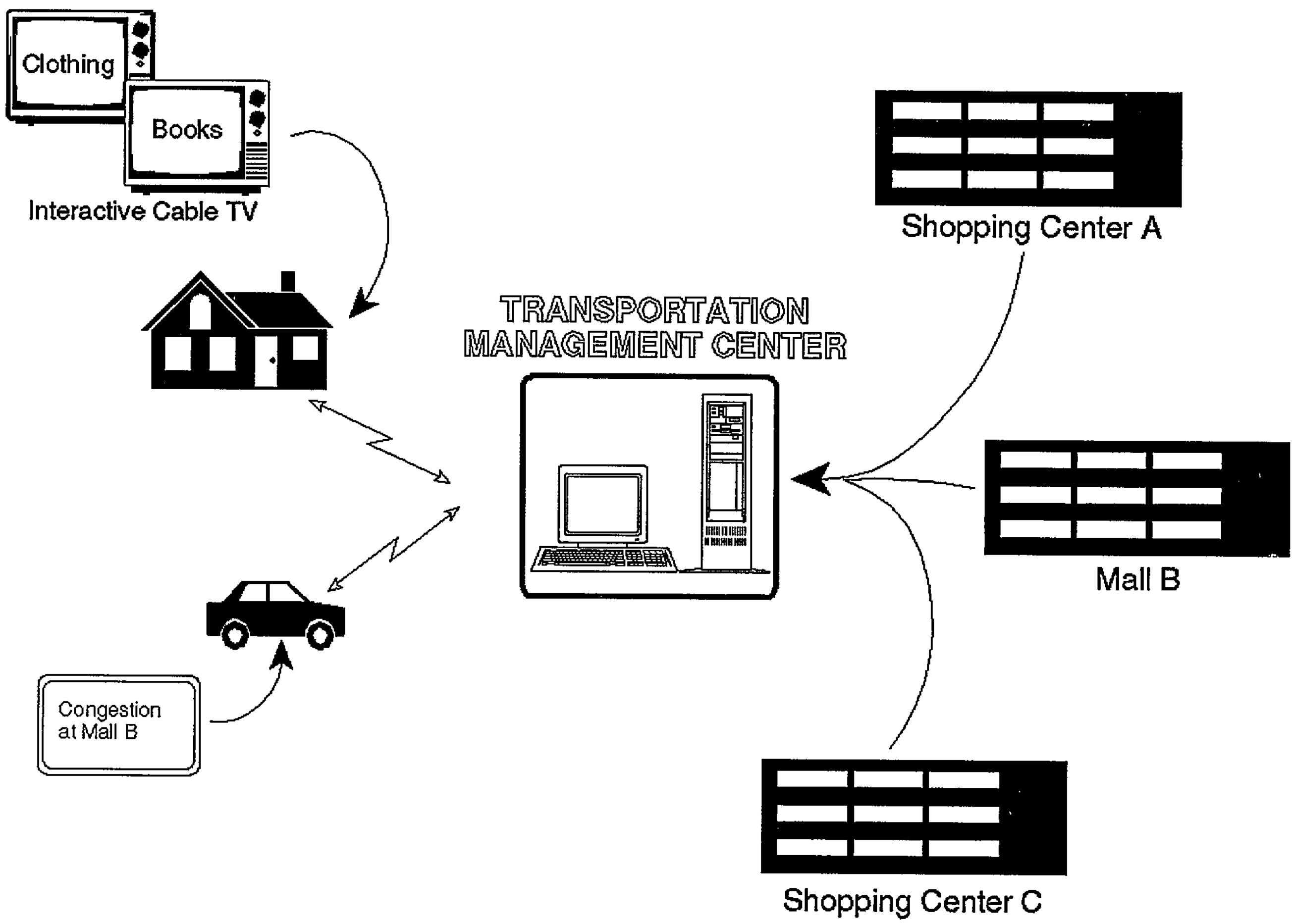
Table 16. Scenario 16. Real-time transportation information.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would provide real-time multimodal transportation information to travelers in homes, workplaces, and stores.
2. Technically Feasible?	YES	Could use standard cable TV, videotext systems and emerging interactive cable TV to disseminate information.
3. Potential Benefits	HIGH	Could reduce congestion and delays, fuel consumption and pollution emissions, and improve use of existing facilities.
4. Potential Costs	MODERATE	Would require information terminals to be available in stores, workplaces, and high activity centers.
5. Institutional/Legal Barriers	MODERATE	May require multi-jurisdictional cooperation to collect and distribute information, especially if private operation is considered.
6. Financially Feasible?	YES/ UNCERTAIN	If operated as part of public ATMS/ATIS additional costs should be reasonable. Feasibility of private operation is uncertain.
7. Attractiveness to Users, Operators, and Society	HIGH	Should be highly attractive to users and society as a whole. Should also be attractive to operators as part of TSM strategies.
8. Human Factors Effectiveness	HIGH	User friendliness and information reliability will be essential for the success of this scenario.
9. Potential for Success	HIGH	Will provide benefits to a large segment of the population. For maximum effectiveness, it should be integrated into regional ATIS.
10. Implementation Potential	HIGH	Some operational tests underway. Interest appears to be strong.

SCENARIO NO. 17
NEEDS SCHEDULING

GOAL: Reduce congestion and VMT by managing shopping trips.



SCENARIO

1. In-home or in-vehicle unit informs driver of congestion at shopping destination.
2. Driver enters trip purpose. System displays other areas where items are available.
3. Alternatively, system offers shop-at-home services.

Figure 20. Needs scheduling.

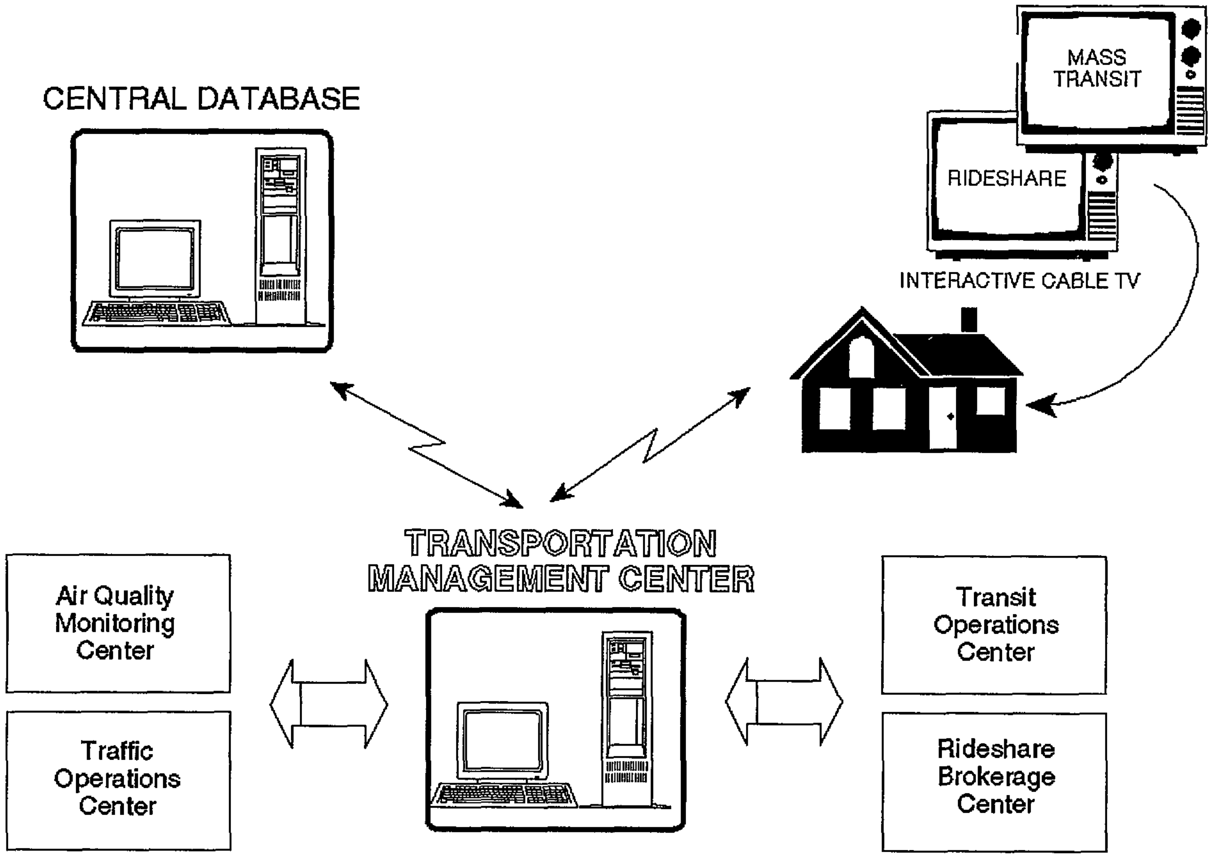
Table 17. Scenario 17. Needs scheduling.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Could provide true transportation demand management in arcas experiencing congestion.
2. Technically Feasible?	**YES**	Some basic shop-at-home services are available today. Will need to coordinate with ATMS/ATIS systems for traffic information.
3. Potential Benefits	MODERATE	Reduced congestion and delay and possibly reduced VMT.
4. Potential Costs	MODERATE	Would require control center linking traffic and commercial databases. Would probably require a user fee.
5. Institutional/Legal Barriers	HIGH	May be seen as "favoring" some stores over others. Retail operators may not want customers diverted away for any reason.
6. Financially Feasible?	YES	May be suitable for private operation. User fees (per use or subscription) could probably cover operating costs.
7. Attractiveness to Users, Operators, and Society	HIGH/ LOW	Should be very attractive to users and society as a whole, but retail operators may fmd it unattractive.
8. Human Factors Effectiveness	HIGH	Information must be reliable or users will quickly lose confidence in the system. Should provide route guidance as well.
9. Potential for Success	MODERATE	Success will depend ultimately on the cooperation of retailers.
10. Implementation Potential	MODERATE	May have greatest potential under private operation. Area of applicability may be primarily high and medium density areas.

SCENARIO NO. 18
AIR POLLUTION ALERT

GOAL: Reduce mobile source emissions and encourage use of alternate modes during non-attainment periods.



SCENARIO

1. Air Quality monitoring center identifies non-attainment areas or forecasts potential air quality problems.
2. Persons within these areas are notified and presented with alternate travel modes.
3. Road pricing policies could be implemented using AVI equipment on cars.
4. Real-time travel data allows cities to adjust management strategies once they have been implemented.

Figure 21. Air pollution alert.

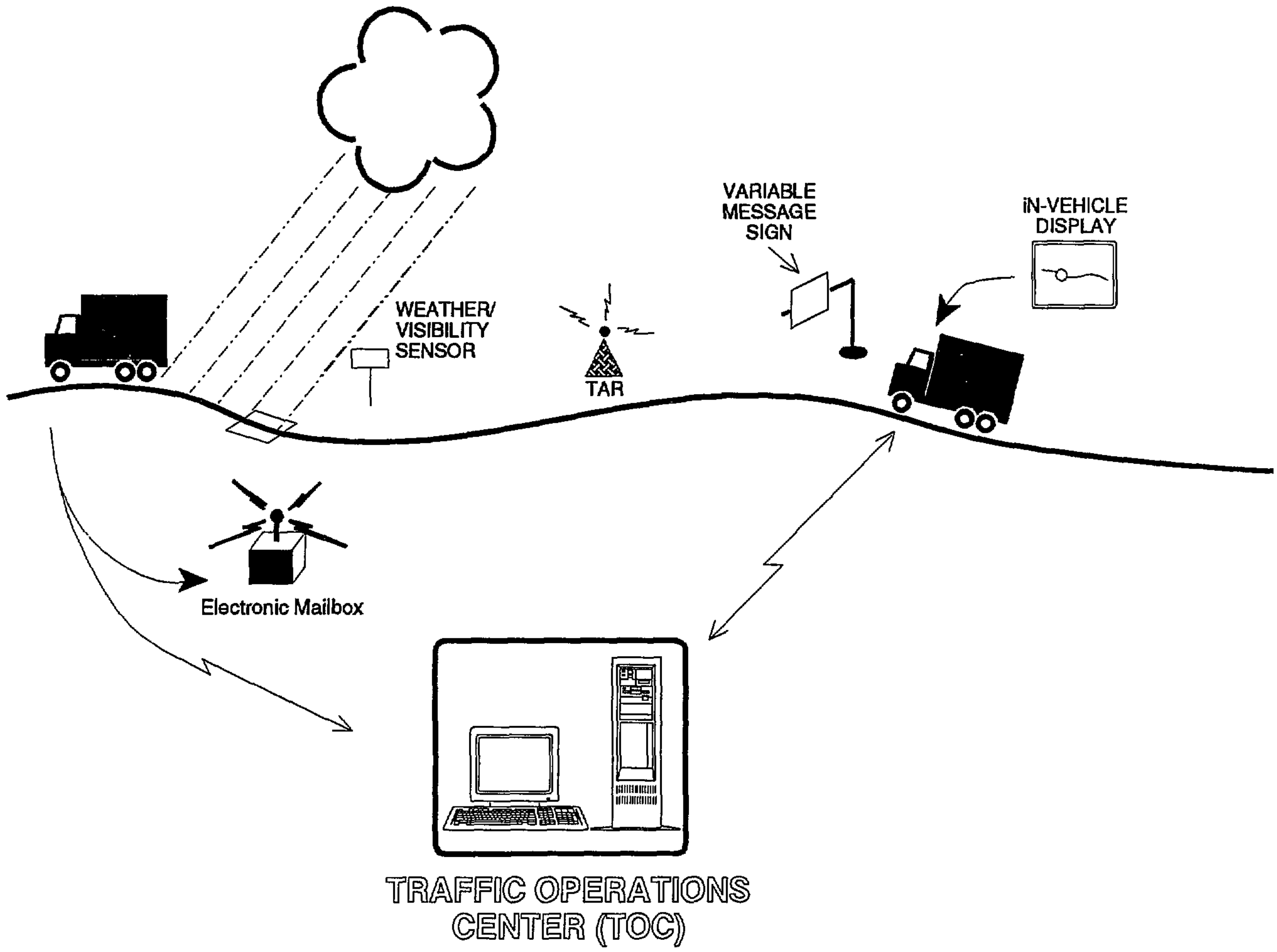
Table 18. Scenario 18. All quality alert.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would permit implementation of multimodal transportation controls to meet air quality attainment goals.
2. Technically Feasible?	YES	Would largely use other IVHS systems to gain and disseminate information.
3. Potential Benefits	HIGH	Could help reduce mobile emissions and facilitate use of other modes.
4. Potential Costs	MODERATE	If system uses existing lVHS infrastructure, additional costs should be moderate.
5. Institutional/Legal Barriers	MODERATE	Will require regional (multi-jurisdictional) pollution control authority to coordinate mitigation measures.
6. Financially Feasible?	YES	Services could be provided through other IVHS systems. Would not need to dedicate an entire system solely to this purpose.
7. Attractiveness to Users, Operators, and Society	MODERATE	While mitigation measures themselves may be seen as unattractive, this system should be useful for users and operators during alerts.
8. Human Factors Effectiveness	HIGH	Will increase information available to travelers during alerts. Information will need to be accurate, timely, and accessible.
9. Potential for Success	HIGH	Should be a useful element of regional air quality plans. Could help to significantly reduce mobile source emissions.
10. Implementation Potential	HIGH	The CAAA '90 set out federal mandates to address air quality problems. Thii will be a major concern for non-attainment areas.

SCENARIO NO. 19
AUTOMATIC WEATHER/ROAD CONDITION MONITORING

GOAL: Supplement fixed sensor monitoring systems and expand coverage using vehicle probes.



SCENARIO

1. Police, maintenance, and commercial vehicles act as probes and detect hazardous weather, visibility, and road conditions using on-board sensors.
2. Probe vehicles transmit road condition data to roadside "electronic mailboxes" or to a TMC.
3. Other vehicles receive warning information and are guided around hazardous locations.

Figure 22. Automatic weather/road condition monitoring.

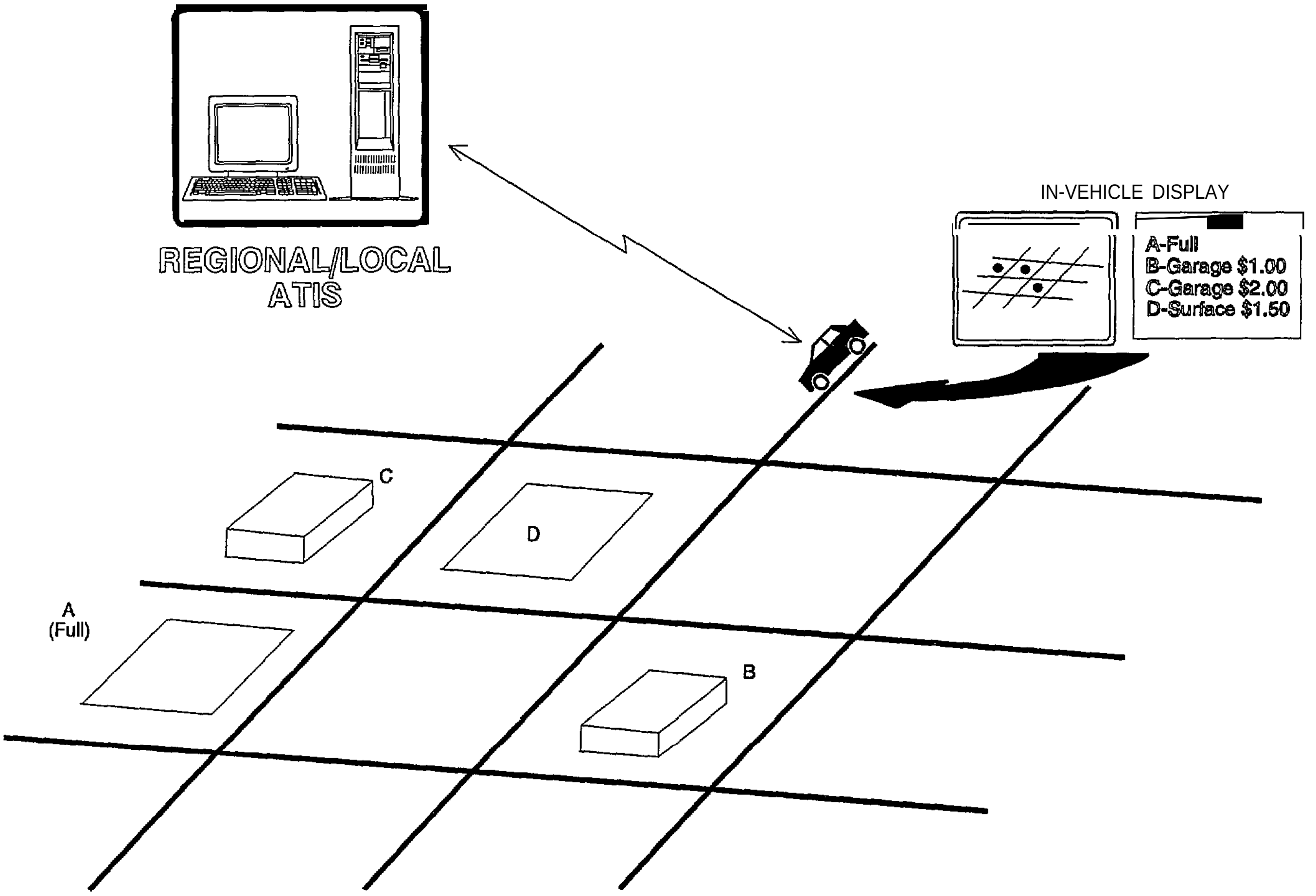
Table 19. Scenario 19. Automatic weather/road condition monitoring.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would be useful to autos and commercial vehicles in detecting hazardous roadway conditions.
2. Technically Feasible?	YES	Detectors and "electronic mailbox" technology currently under development.
3. Potential Benefits	HIGH	Could improve safety and reduce accidents due to poor road and visibility conditions.
4. Potential Costs	LOW to MODERATE	Cost will Depend on types of sensors (fixed vs. vehicle probes) and information systems (HAR and CMS vs. in-vehicle ATIS) used.
5. Institutional/Legal Barriers	LOW	Will require communication standards for in-vehicle sensors and ATIS units (both private and commercial).
6. Financially Feasible?	YES	Could reduce system operating costs through extensive automation and reduction in infrastructure requirements.
7. Attractiveness to Users, Operators, and Society	HIGH	Attractive to both highway users and operators
8. Human Factors Effectiveness	HIGH	Could provide more detailed real-time information (both audio and video) than conventional changeable message signs or HAR.
9. Potential for Success	HIGH	Similar, though less complex systems currently in operation.
10. Implementation Potential	HIGH	Could allow more extensive use of these warning systems, not just in areas of the most severe nature.

SCENARIO NO. 20
ATIS SYSTEM: PARKING AVAILABILITY

GOAL: Facilitate the location of available parking in congested areas. This would be one module in a mature ATIS System.



SCENARIO

1. Parking lots, garages, and transit park & ride lots continuously update parking availability.
2. On-board ATIS unit displays available parking, parking fees, and lot type (surface or garage).
3. User reserves a space and is guided to lot.
4. Advanced systems would monitor the availability of on-street parking and loading zones in congested areas.

Figure 23. ATIS system: parking availability.

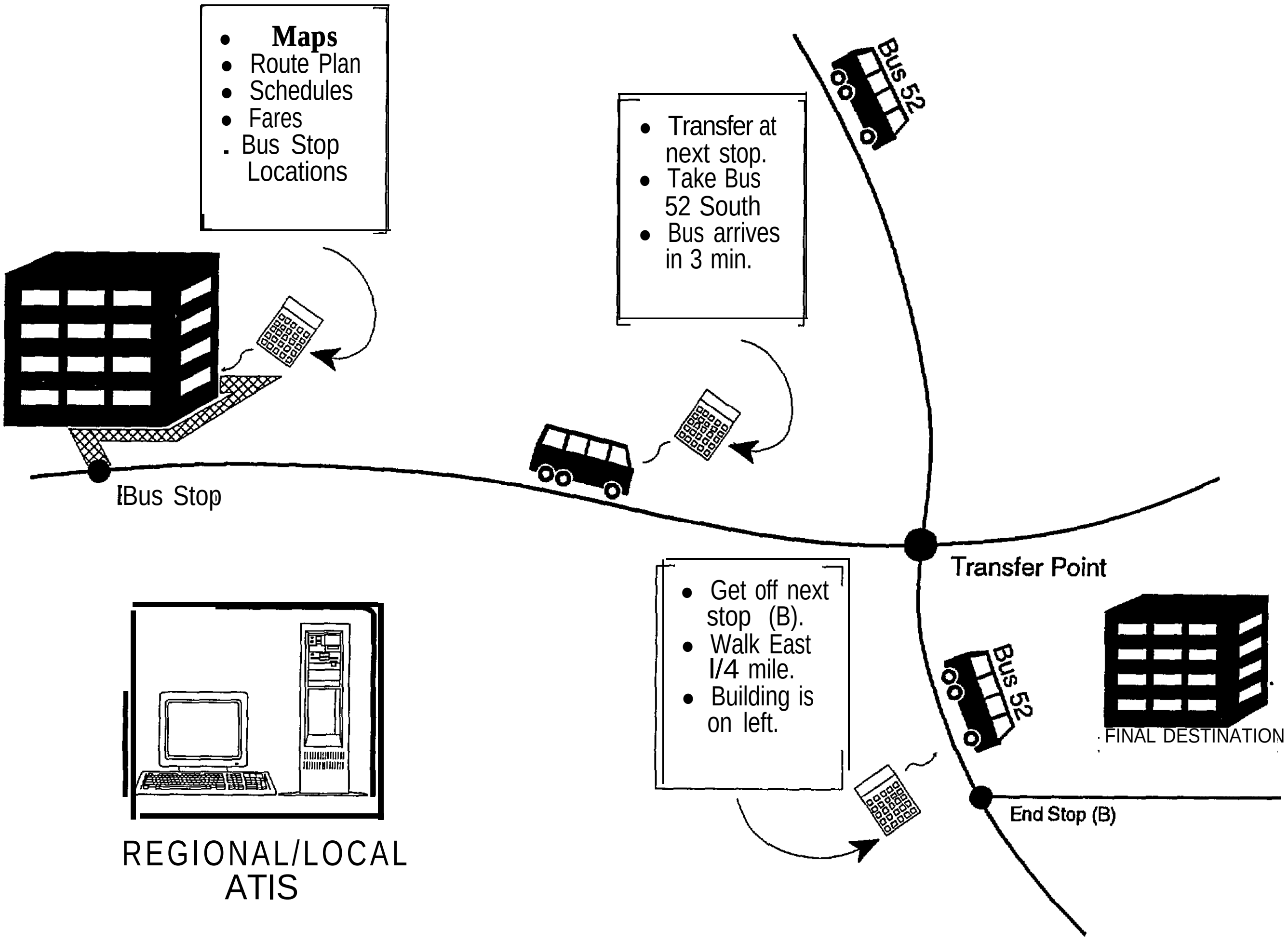
Table 20. Scenario 20. ATIS system: parking availability.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YE!3	Could be applied to parking for passenger cars and loading areas for commercial vehicles.
2. Technically Feasible?	**YES**	Most of the necessary technology exists, but will most likely require a fully operational ATIS to be successful.
3. Potential Benefits	HIGH	Could result in reduced congestion, better utilization of existing parking facilities, and parking management during special events.
4. Potential Costs	MODERATE	Much of the cost could be subsidized by parking facility operators. Monitoring on-street parking could prove more expensive.
5. Institutional/Legal Barriers	LOW	Few barriers to system itself. Control of system (public vs. private) may be an issue in terms of being fair to all parties.
6. Financially Feasible.	**YES**	Monitoring commercial lota should be feasible. Monitoring on-street parking may require additional funding.
7. Attractiveness to Users, Operators, and Society	HIGH	Increased convenience for motorists, better utilization for providers, and congestion reduction for entire area.
8. Human Factors Effectiveness	HIGH	Will need to address same concerns as any in-vehicle ATIS system.
9. Potential for Success	IIIGH	In high activity areas and for special events, this system should have a fairly high demand.
10. Implementation Potential	HIGH	Should be fairly high in an environment with fully operational ATIS.

SCENARIO NO. 21
PORTABLE ATIS SYSTEM

GOAL: Provide real-time travel directions to any destination on a multi-modal transit system.



SCENARIO

1. User keys in destination to pocket ATIS unit. Unit receives real-time transit information.
2. Unit provides optimum route, bus stop locations, fares, and real-time schedule information.
3. Unit monitors position, indicates when to disembark or transfer, and provides walking directions to final destination.

Figure 24. Portable ATIS system.

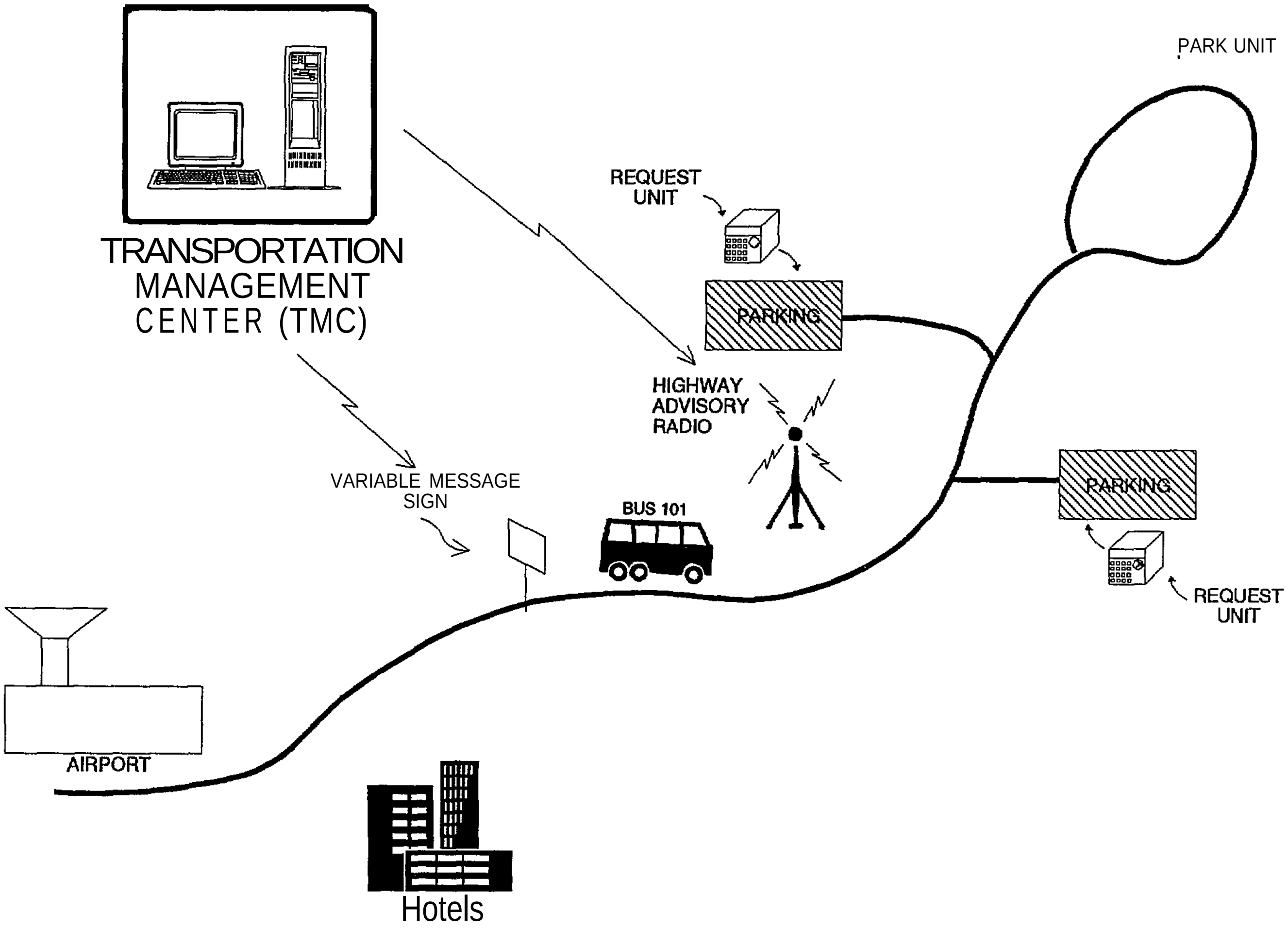
Table 21. Scenario 21. Portable ATIS system.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would provide multimodal travel information in a unit that could be used in a car, on transit, or carried by user.
2. Technically Feasible?	YES	Portable units using static information (preprogrammed maps and travel data) are available today.
3. Potential Benefits	HIGH	Could be used in-vehicle or carried by traveler. Also useful for tourists and travelers.
4. Potential Costs	LOW (System-wide)	No additional implementation costs. Unit costs borne by the user.
5. Institutional/Legal Barriers	LOW	Will require standardization of communication protocols to be useful in different areas/regional systems.
6. Financially Feasible?	YE!S	Unit costs will have to be reasonable enough to assure wide market penetration.
7. Attractiveness to Users, Operators, and Society	MODERATE	Could be very attractive to users, especially during transitional implementation of in-vehicle ATIS.
8. Human Factors Effectiveness	MODERATE	Would raise many of the issues associated with conventional in-home and in-vehicle ATIS displays,
9. Potential for Success	HIGH	Should be very high if unit cost is reasonable.
10. Implementation Potential	HIGH	Simple static information versions are already on the market.

SCENARIO NO. 22
TRAFFIC MANAGEMENT AT NATIONAL PARKS

GOAL: Reduce traffic congestion in National Park areas and improve park environment.



SCENARIO

1. Visitors are notified of congestion in park areas via ATIS units, HAR, VMS,and information kiosks.
2. Motorists are directed to off-site parking lots via message signs and ATIS units.
3. Users enter call request and transit vehicles are automatically dispatched to lots.

Figure 25. Traffic management at parks/monuments.

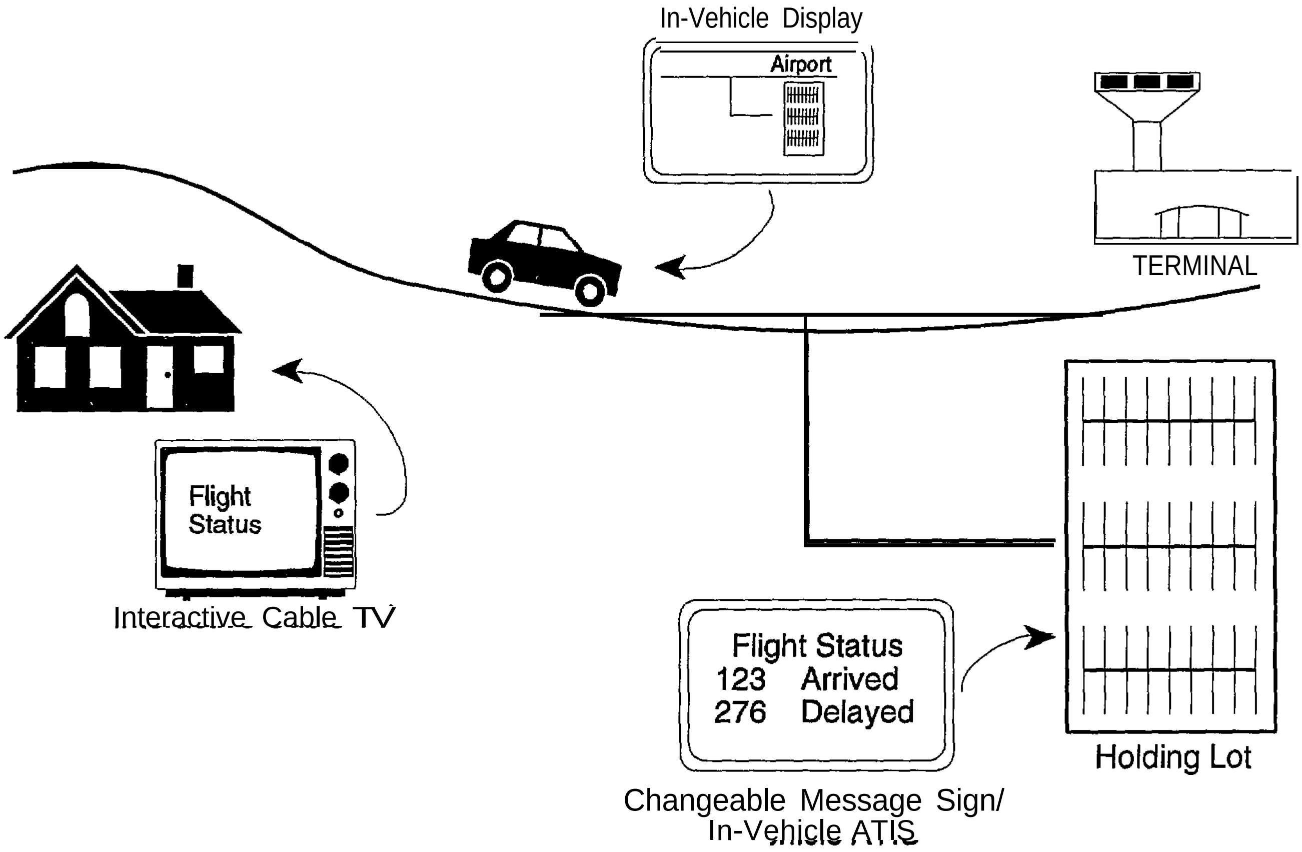
Table 22. Scenario 22. Traffic management at parks/monuments.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would provide real-time traffic management for autos and buses at parks and monuments.
2. Technically Feasible?	YES	Would be part of regional ATIS systems.
3. Potential Benefits	HIGH	Would allow park operators to reduce congestion and improve park environment through real-time traffic management.
4. Potential Costs	MODERATE	Would require a control center to manage auto and bus traffic. Would place restrictions on personal auto use.
5. Institutional/Legal Barriers	MODERATE	Would require nationwide ATIS communication standards, Would also require cooperation of local police for enforcement.
6. Financially Feasible?	YES	Could be financed by park services through user fees and integrated into regional ATIS system.
7. Attractiveness to Users, Operators, and Society	HIGH	Would benefit all by reducing congestion in parks and surrounding areas and improving park environment.
8. Human Factors Effectiveness	HIGH	Will have the same requirements as conventional ATIS systems.
9. Potential for Success	HIGH	Should be high. Congestion is a growing problem at many urban and rural parks.
10. Implementation Potential	HIGH	Several parks have expressed an interest in implementing traffic management systems.

SCENARIO NO. 23
AIRPORT ACCESS - PASSENGER PICK-UP

GOAL: Improve guidance and reduce congestion associated with passenger pick-up at airports.



SCENARIO

1. Airport users check status of flights from home unit (cable TV or home computer).
2. Upon arrival at airport, user is informed of flight status and directed to pick-up point.
3. If flight is delayed, user is directed to holding lot and informed when flight arrives.
4. During periods of severe congestion, users could be directed to external lots and take transit.

Figure 26. Airport access - passenger pick-up.

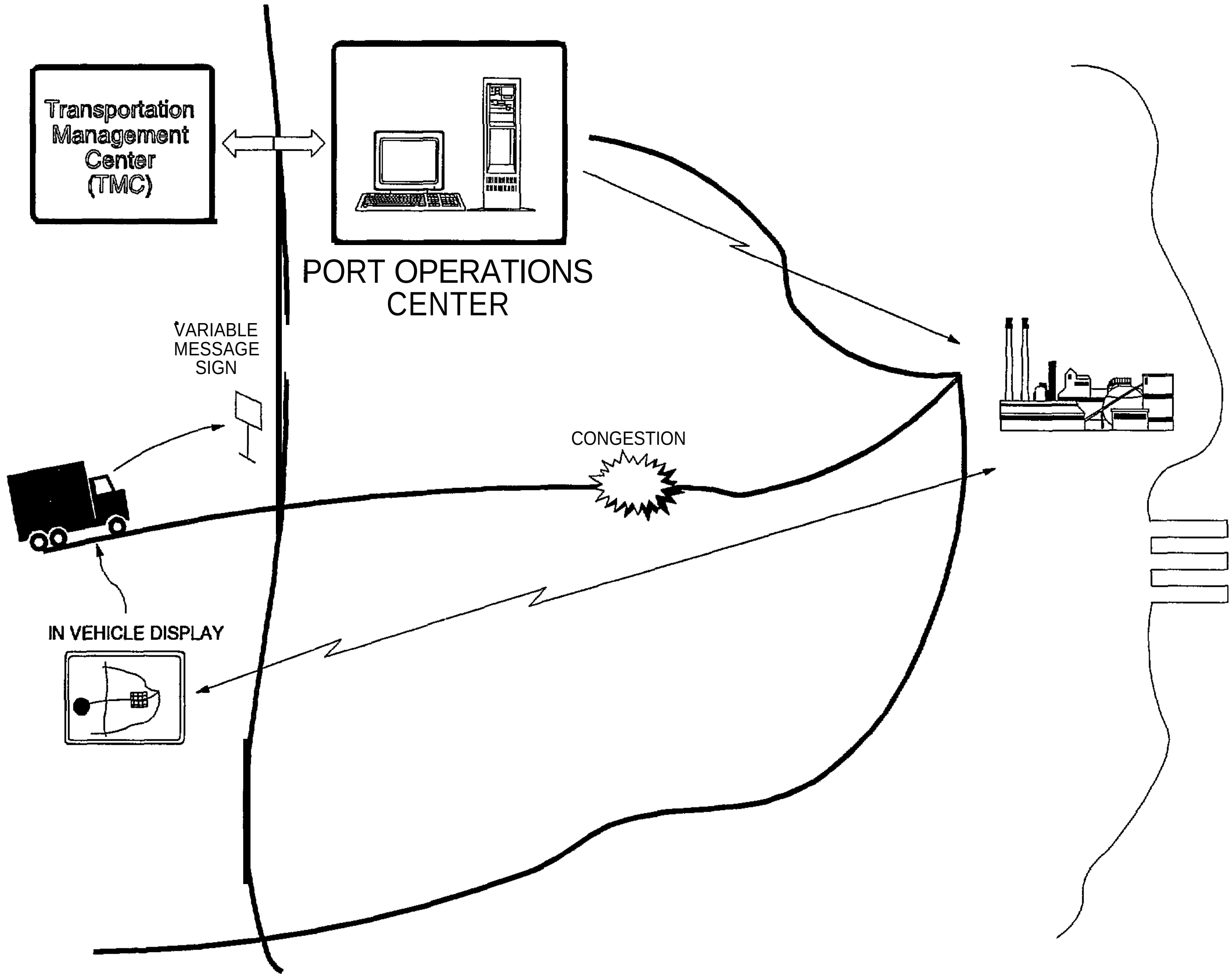
Table 23. Scenario 23. Airport access/passenger pick-up.

General Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would provide coordination between air and highway modes to relieve congestion at airports.
2. Technically Feasible?	YES	Could be operated using existing technologies. Will be most effective with use of m-vehicle ATIS.
3. Potential Benefits	MODERATE	Would allow travelers to receive real time flight information at home/work. Would provide curbside traffic management at airport.
4. Potential Costs	MODERATE	Could use flight information systems already in place at most airports. Incremental operating costs should be low.
5. Institutional/Legal Barriers	LOW	Will require cooperation with local transportation management systems/agencies. May need agreement with cable TV operators.
6. Financially Feasible?	YES	Benefits should justify the fairly moderate installation and operating costs.
7. Attractiveness to Users, Operators, and Society	HIGH	Attractive to both users and operators.
8. Human Factors Effectiveness	HIGH	Should be able to use the same information displays currently used in airports.
9. Potential for Success	HIGH	For maximum effectiveness, should be integrated into regional ATMS.
10. Implementation Potential	HIGH	Would address a serious problem faced by many airports.

SCENARIO NO. 24
DYNAMIC ROUTE SCHEDULING FOR TRUCK ACCESS TO PORT FACILITIES

GOAL: Improve efficiency of truck movements in and out of port facilities/truck centers.



SCENARIO

1. Port Operations Center transmits real-time traffic data and optimum routing for trucks headed to port.
2. On-board route guidance guides driver to port facility.
3. GE-based system guides trucks with special needs based on size, geometries, population, etc.

Figure 27. Dynamic route scheduling for truck access to port facilities.

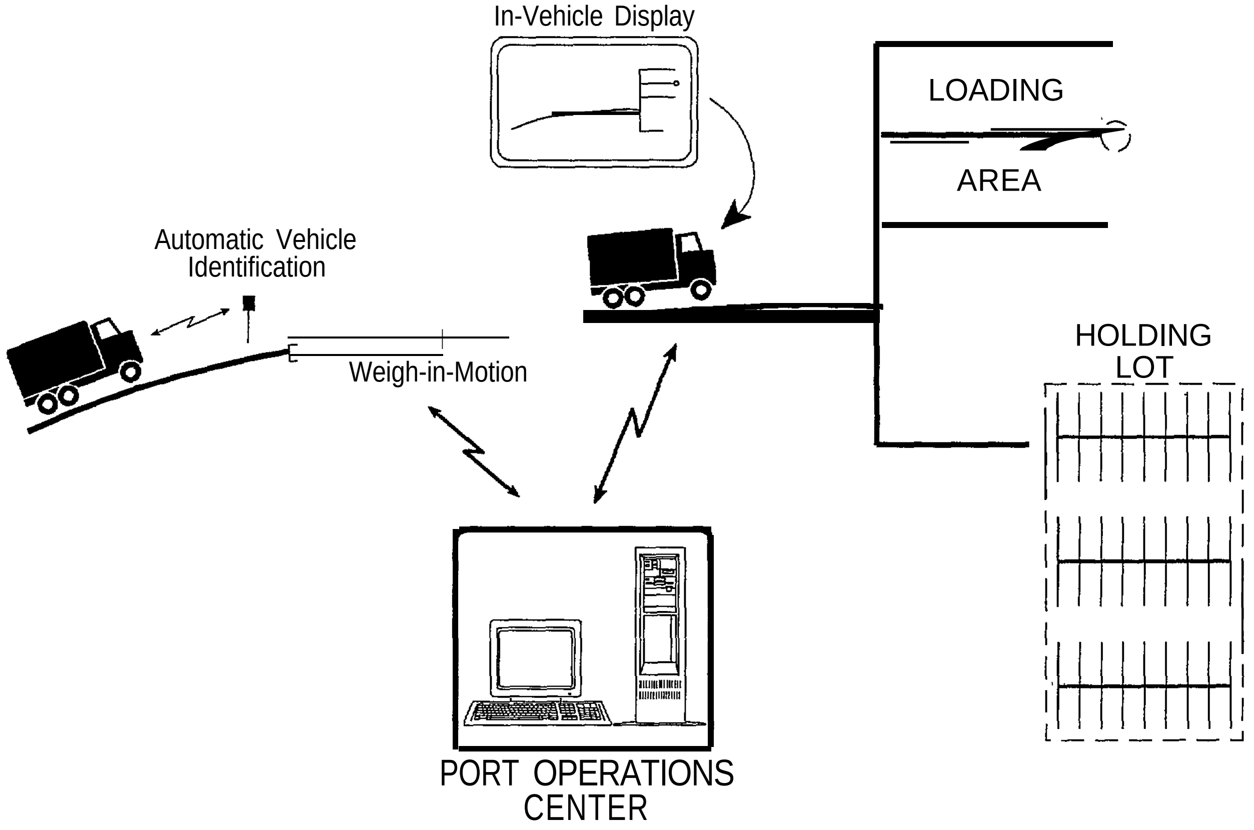
Table 24. Scenario 24. Truck access to ports/rail facilities.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would enhance the interface between highway and rail/shipping modes.
2. Technically Feasible?	YES	Most of the required technology is in use or is being tested today.
3. Potential Benefits	HIGH	Could provide dynamic route guidance for trucks using transfer facility, reduce congestion, and improve efficiency.
4. Potential Costs	MODERATE	Would require a control center. Could interface with other ATMS facilities to obtain much of the transportation data.
5. Institutional/Legal Barriers	FEW	Will require cooperation with local TMC's and transportation authorities.
6. Financially Feasible?	YES	Could be financed through port usage fees. Operating costs should be relatively low.
7. Attractiveness to Users, Operators, and Society	HIGH	Most attractive in areas that experience serious congestion. Benefits users, operators, and society.
8. Human Factors Effectiveness	HIGH	Should be high if automatic vehicle identification systems and in-vehicle information displays used.
9. Potential for Success	MODERATE	Most likely success in areas where other ATMS and traffic management systems are in operation.
10. Implementation Potential	MODERATE	Would be particularly useful in urban and high density areas where congestion and access are problems.

SCENARIO NO. 25
IMPROVED VEHICLE PROCESSING AT PORT FACILITIES/TRUCKING CENTERS

GOAL: Reduce delays and congestion associated with vehicle processing at port facilities/trucking centers.



SCENARIO

1, Truck entering port is automatically identified and weighed by AVI and WIM systems.

2. Computer guides truck to loading point via in-vehicle ATIS and monitors its location within the facility.

3. Vehicles forced to wait for loading could be directed to holding lots and notified when needed.

4. During peak periods, trucks could be directed to wait at external lots until needed.

Figure 28. Improved vehicle processing at port facilities/trucking centers.

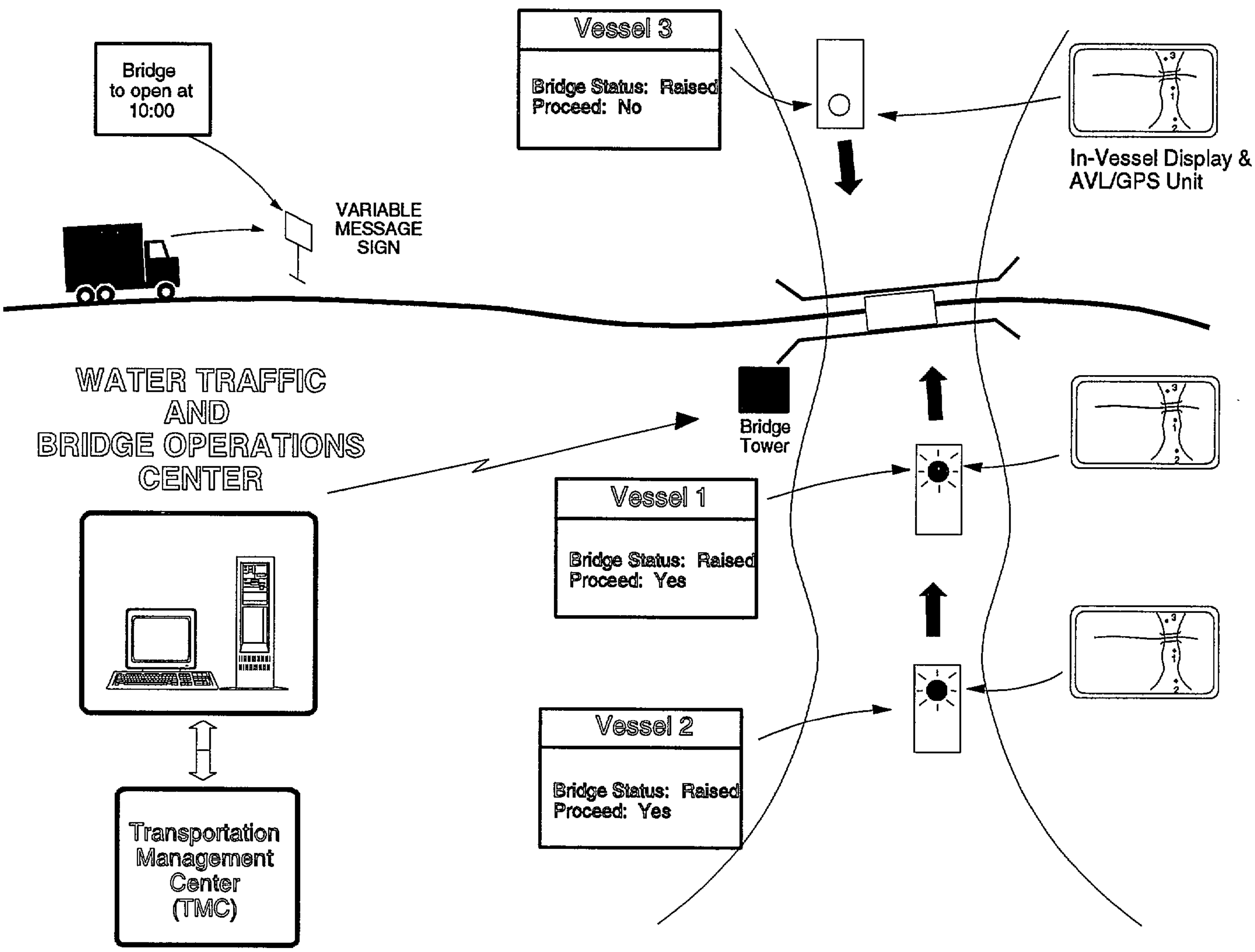
Table 25. Scenario 25. Improved vehicle processing at ports/trucking facilities.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Will enhance the interface between port/rail and highway modes of goods movement.
2. Technically Feasible?	YES	WIM, AVI, and AVL systems are being tested in several projects, although it would require improvements in WIM accuracy.
3. Potential Benefits	HIGH	Would reduce congestion and delays at processing centers. Would allow monitoring of vehicles and goods within facility.
4. Potential Costa	MODERATE	Would require some new equipment and a control center. Much of the in-vehicle equipment may be in standard use in the future.
5. Institutional/Legal Barriers	LOW	Ensuring compatibility with other AVI systems may be one of the key issues facing such a system.
6. Financially Feasible?	YES	Benefits should outweigh costs of system operation. Could be financed through port user fees.
7. Attractiveness to Users, Operators, and Society	HIGH	Benefits all parties through reduced costs and delays and increased operating efficiency.
8. Human Factors Effectiveness	HIGH	Should be easy for system users. Could automate many of the functions currently performed by people.
9. Potential for Success	HIGH	Potential for success could be maximized if system were integrated into surrounding highway CVO systems.
10. Implementation Potential	HIGH	Similar systems are being tested as part of the HELP and ADVANTAGE I-75 programs. Interest in CVO is strong.

SCENARIO NO. 26
REAL-TIME COORDINATION OF WATER TRAFFIC AND BRIDGE OPERATIONS

GOAL: To improve coordination between vessel movement on waterways and drawbridge operations.



SCENARIO

1. Water traffic/bridge Operations Center schedules vessel traffic to arrive at predetermined times.
2. Control Center monitors location of vessels on waterways. Vessels are instructed to queue and then passed through in groups.
3. Transportation Management Center is advised of all bridge openings. If severe congestion exists,

Figure 29. Real-time coordination of water traffic and bridge operations.

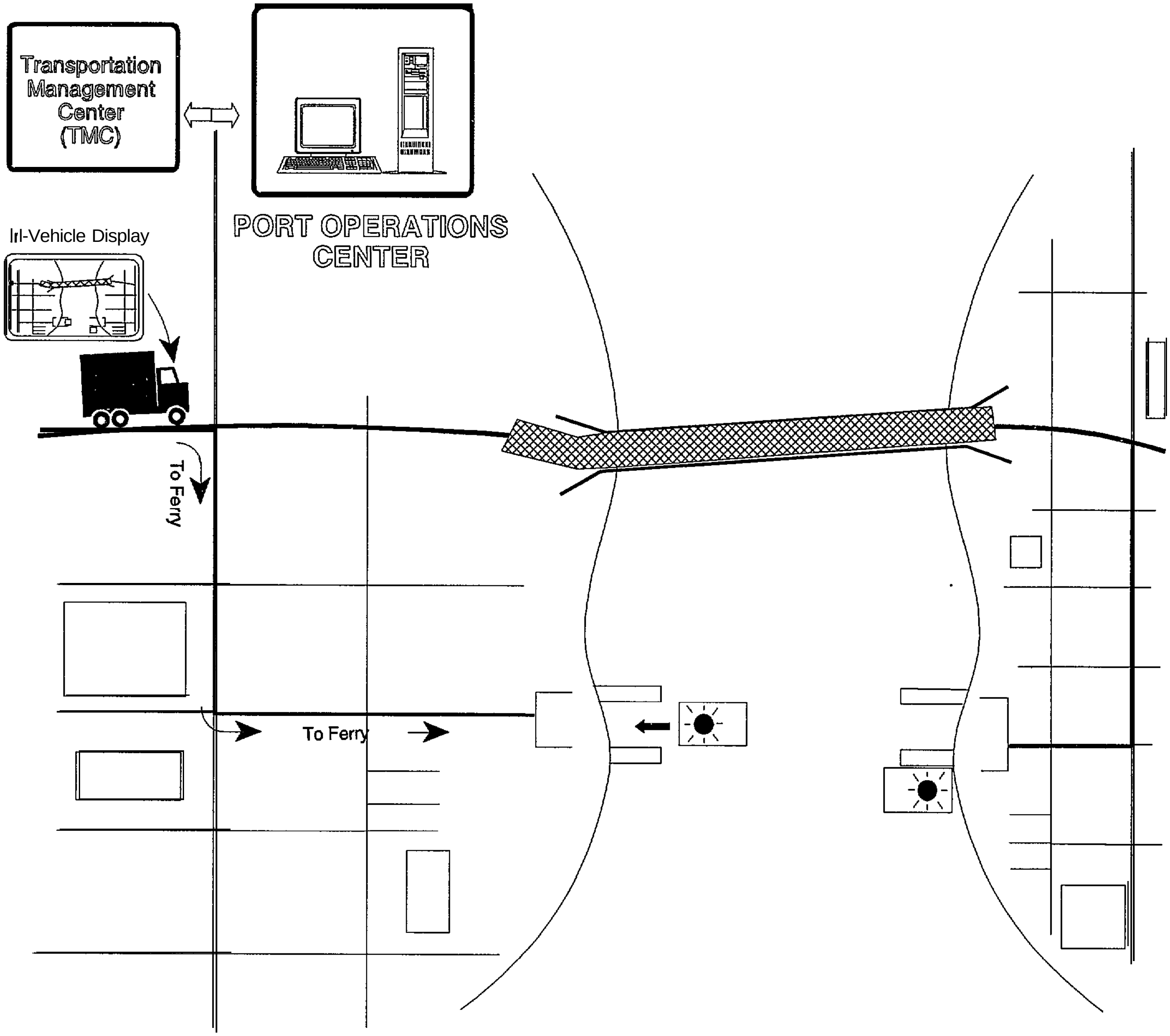
Table 26. Scenario 26. Coordination of water and bridge operations.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would reduce delays to highway traffic without having major impacts on water traffic.
2. Technically Feasible?	YES	Would require some form of AVL, information displays, and control centers to monitor highway and water traffic.
3. Potential Benefits	MODERATE	Reduced delays to highway traffic. An ATMS/ATIS system would be able to reroute traffic during bridge openings.
4. Potential Costs	MODERATE	Cost to highway users would probably be low. Would require that boats/ships have appropriate communication equipment.
5. Institutional/Legal Barriers	HIGH	Water traffic currently has right-of-way. Would require changes to laws to permit delays in openings.
6. Financially Feasible?	YES	Many agencies already maintain traffic control centers and ATMS equipment near drawbridges.
7. Attractiveness to Users, Operators, and Society	HIGH/LOW	Likely to be very attractive to highway users, unattractive to water users.
8. Human Factors Effectiveness	HIGH	Should not pose any difficulties for users or operators.
9. Potential for Success	MODERATE	Could be effective if the cooperation of the Coast Guard was obtained. Otherwise, it may prove difficult.
10. Implementation Potential	MODERATE	Would be most attractive at high-volume, urban drawbridges. System may not be justifiable at low-volume bridges.

SCENARIO NO. 27
MOVING URBAN GOODS ON FERRIES

GOAL: Ferry trucks with urban goods across waterways to avoid bridge and tunnel traffic.



SENARIO

1. Transportation Management Center transmits real-time bridge traffic data and optimum routing for commercial vehicles that need to use bridge.

2. Commercial vehicles are directed to ferry. AVI and WIM Systems automatically identify, weigh, and bill vehicles.

3. Vehicles forced to wait for ferry could be directed to holding lots and notified when needed.

Figure 30. Moving urban goods on ferries.

Table 27. Scenario 27. Moving urban goods on ferries.

Summary Evaluation

Criteria Category	Summary Rating/Comment	Comments
1. Applicable to MM Transportation Management?	YES	Would enhance urban goods movement in cities where ferries are used.
2. Technically Feasible?	YES	Would require some type of ATIS equipment to be installed in commercial vehicles.
3. Potential Benefits	HIGH	Reduced time spent in traffic, better fleet utilization, reduced operating costs for commercial operators.
4. Potential Costs	MODERATE	Would likely require dedicated ferries for commercial operations.
5. Institutional/Legal Barriers	LOW	Would require cooperation between fleet operators, traffic management agencies, and ferry operators.
6. Financially Feasible7	YES	Would most likely be feasible only in areas where severe congestion exists.
7. Attractiveness to Users, Operators, and Society	MODERATE	Would be attractive to fleet operators and possibly other highway users if it reduces congestion at bridges and tunnels.
8. Human Factors Effectiveness	HIGH	Many fleets already use routing systems and AVI equipment. Should be effective from a human factors standpoint.
9. Potential for Success	MODERATE	Would have a fairly limited range of application (e.g., large cities with ferries such as New York and Seattle).
10. Implementation Potential	MODERATE	May have greatest implementation potential as a public-private joint venture.

3. SITE SELECTION

As part of this study, the prime contractor (BMI) conducted eight 1-day workshops at sites around the country to present some of the interim results of this project to transportation professionals. The contractor proposed 16 candidate sites, from which the FHWA and FTA selected 8 for formal presentations. This section summarizes the site selection criteria, lists the eight sites chosen for formal presentations, and summarizes some of the feedback received at the workshops.

SITE SELECTION CRITERIA

The following criteria were developed for the purpose of evaluating and selecting the 16 candidate sites for formal presentations and possible operational testing. The criteria are as follows:

1. Population and Area Type

As specified in the contract, the 16 candidate sites included:

- Six urbanized areas of 1 million or more.
- Four urbanized areas of 500,000 to 1 million.
- Two urbanized areas of 100,000 to 500,000.
- Four rural areas.

2. Multimodal Transportation System

In keeping with the goals of this study, the candidate sites were to be served by multimodal transportation systems. In the large urban areas these modes could include highway, transit (bus and rail), commuter rail, paratransit, taxi, ferry, air, port, and commercial operations. In the smaller urban and rural areas it is expected that there would be fewer modes present, but some type of multimodal system was still required.

Since many scenarios are designed to shift travel from one mode to another, there should be sufficient overlap between the coverage of the modes so that these shifts are possible and practical. ATIS and route diversion schemes will do little good if there are no alternate routes to which to divert traffic. Similarly, no matter how attractive an IVHS system is offered, people will be unlikely to use transit if the existing transit service has problems related to reliability, convenience, or safety. It will therefore be **necessary to also** examine the quality and extensiveness of the multimodal services available.

3. Existing IVHS Projects/Infrastructure

The presence of operational IVHS systems and infrastructure or ongoing FHWA and FTA operational tests was desirable for several reasons. First, the scenarios assume a certain level of IVHS development as outlined in the "Functional Requirements" of the contract. Areas that have made progress toward achieving these elements or have demonstrated a willingness to accept them would provide settings more similar to those for which the scenarios were intended. Second, the presence of other operational IVHS systems would permit interactions that could produce benefits beyond those that either system would produce on its own. This too would create an environment more similar to that assumed in the functional requirements. Finally, from a cost perspective, the presence of existing IVHS infrastructure could reduce the costs associated with operational testing and avoid needless duplication of systems such as transportation management centers (TMC's) and communication networks.

4. Willingness of Transportation Officials/Agencies to Participate

The willingness of State and local governments and transportation agencies to participate in the study and dedicate staff was essential in evaluating potential test sites. Cities and areas that have successfully demonstrated or implemented IVHS type projects in the past or have demonstrated enthusiasm through the informal outreach portion of this study or through completion of State/regional IVHS strategic plans were given consideration.

5. Willingness of Institutions to Cooperate with Each Other

The public agencies and private entities required for the testing or implementation of a scenario must have **a** demonstrated willingness to work with each other. These agencies will include not only local highway and transit agencies, but also local governments, public service providers (police, fire, and incident management teams), private transportation providers (taxi, paratransit, senior citizens organizations), commercial operators (couriers, truckers, ports), airports, IVHS manufacturers, and in some cases banks or other financial institutions. Institutional barriers have been identified by many as the biggest obstacle to testing and implementing IVHS systems. The willingness of implementing agencies to cooperate with one another was a key factor in evaluating potential sites.

6. Severity of Transportation/Mobility Problems

In order to properly evaluate the benefits and costs of these scenarios they should be tested in areas where their effects on congestion, transit ridership, or HOV usage can be readily measured. It would be desirable in many cases to test the scenarios in areas that have significant problems with traffic congestion, transit efficiency/reliability, or urban goods movement. This would not, however, be a strict requirement as many of the scenarios can be readily tested in areas that do not suffer from severe transportation problems.

7. Geographic Distribution

An examination of the location of current IVHS operational test programs shows that much of the activity is focused in large urban areas and on the east and west coasts. This study was careful to consider all areas of the country and all area types.

8. Funding

The Federal Government requires participation by others in the funding of IVHS demonstration projects. The level of non-federal participation was considered in evaluating the potential sites.

The site selection criteria were not given specific weighting. These types of criteria do not easily lend themselves to rigid quantification. In the end, the selection of the potential sites relied on subjective judgements by the research team and input from the FHWA and FTA.

PRELIMINARY PRESENTATION SITES

Listed below are the sites which were chosen for task D site visits. These 8 sites were selected by FHWA and FTA from a list of 16 candidate sites recommended by the contractor.

Large Urban Areas (Population of 1 Million or more)

1. San Francisco Bay Area: The San Francisco Bay Area Partnership, an organization of Federal, State, regional, and local agencies, has been formed to deal with transportation issues in the Bay Area. The Bay Area is currently testing multimodal fare payment media and will be testing a comprehensive multimodal traveler information system.

2. Minneapolis-St. Paul. MN: IVHS projects include Guidestar (Twin Cities Freeway Management System), the Twin Cities Smart Traveler project (smart cards), a real-time traffic and transit information system, dynamic ridematching, and a freeway incident management program.

3. Baltimore-Washington-Montgomery County. MD: Maryland has implemented a freeway ATIS system (CHART), an urban congestion alleviation system (VMS and TAR) that receives traffic information from a variety of sources, and a Smart Bus system (on-board AVL). The Maryland DOT has expressed an interest in testing ATIS and port management scenarios in the Baltimore-Washington area. Both Montgomery County and Washington, DC are implementing advanced traffic and freeway management systems.

Medium Urban Areas (500,000 to 1 Million)

4. Orlando, FL: A TravTek demonstration project is currently underway. A traffic management center is in place. Public-private cooperation has been demonstrated.

5. Anaheim, CA: The city has an ATMS system and will be testing an adaptive traffic signal control system for special events. Caltrans is examining ways of providing transit information to users at kiosks and onboard buses.

Small Urban Areas (100,000 to 500,000)

6. Fredericksburg. VA: This city is examining potential HOV and dynamic ridematching scenarios.

Rural Areas

7. Beaver County. PA: A small transit system has installed an AVL system on its bus fleet.

8. Boise, Idaho: Boise will be evaluating different environmental sensor systems along the I-84 corridor.

4. OPERATIONAL TEST RECOMMENDATIONS

This section identifies those scenarios which hold the greatest potential for immediate operational testing and implementation. These scenarios were chosen based on the evaluations performed under Task B and feedback received from transportation professionals during the Task C Presentation and the Task D site visits. These scenarios were judged to hold significant potential benefits while facing surmountable if not minor technological or institutional barriers.

SCENARIOS RECOMMENDED FOR OPERATIONAL TESTING

The following scenarios are recommended for operational testing. Each recommended operational test is summarized on an operational test form. On each form is a brief discussion of the scenario, the types of sites where it could be tested, and related operational tests that it could be combined with. (Detailed descriptions of the potential benefits, costs, and institutional issues associated with each scenario are provided in appendix A).

CORRELATION OF THE SCENARIOS WITH ONGOING OPERATIONAL TESTS

A separate deliverable will be prepared to correlate the 27 scenarios defined here with some 80 planned and on-going operational tests. For this effort, project team members met with representatives from FHWA, FTA, NHTSA, FRA, FAA, MARAD, and the USCG to discuss current and planned operational test activities. A comprehensive list of operational tests was then developed and correlated with the 27 scenarios defined in this project so as to better identify where these scenarios could be combined with on-going test programs. The end result of this work will be a report that documents all Federally sponsored IVHS activities, identifies potential test sites for the scenarios presented here, and makes recommendations for further research and test activities. As of the writing of this final report, 80 projects were identified as noted in tables 41 through 44.

Table 28. Transit route deviation.

Project Title: Transit Route Deviation

Related Scenario: #1 - Route Deviation/Dynamic Stop Requests and Routing

Applicable Mode(s): P = Primary S = Secondary

____ Highway _S__ Paratransit ____ Airport

P___ Transit ____ Port

IVHS Functional Area(s):

_____ ATMS P___APTS ____ AVCS

S____ ATIS ____ CVO

Area(s) of Applicability:

P Large Urban P Medium Urban P Small Urban S Rural

Description: This test would evaluate the use of transit route deviation to serve off-peak demand and ADA eligible riders. This type of scenario has been tested both in Europe and in the United States with varying success. This operational test could incorporate state-of-the-art AVL, route guidance, and smartcard technologies to further enhance its effectiveness.

Related Projects: Flexible Operations Command and Control System (FOCCS) -Portland, OR
Flexibility Operated Transit (University of Pennsylvania)
Madison, WI Flexibly Operated Transit System
Various transit vehicle AVL systems (22 cities in U.S.)

Table 29. Real-time position and arrival information.

Project Title: Providing Real-Time Position and Arrival Information for Transit Vehicles to Transit Users

Related Scenario: #2 - Real-Time Bus Position and Arrival Information

Applicable Mode(s):

_____ Highway   __S__Paratransit   _____ Airport

__P__ Transit   _____ Port

IVHS Functional Area(s):

_____ATMS   __P__ ATIS   _____ AVCS

__S__ ATIS   _____ CVO

Area(s) of Applicability:

_P_ Large Urban   P_Medium Urban   S_ Small Urban   __ Rural

Description: The provision of real-time bus location information would assure transit users that their bus is going to arrive on time. By eliminating uncertainty over when a bus is going to arrive, this system may improveridership while enhancing transit convenience for users.

Related Projects:
Ann Arbor
Bus Transit Travel Information Test, Colorado
MTA Travel Information, New York City
Boston Smart Traveler
Houston Smart Commuter

Table 30. Smartcard fare collection.

Project Title: Smartcard Fare Collection

Related Scenario: #5 - Smartcard Fare Collection

Applicable Mode(s): P = Primary S = Secondary

____ Highway _P__ Paratransit ____ Airport

P___ Transit ____ Port

IVHS Functional Area(s):

_____ ATMS P___APTS ____ AVCS

_____ ATIS ____ CVO

Area(s) of Applicability:

P Large Urban S Medium Urban S Small Urban __Rural

Description: The use of smartcards as a fare payment media could make travel between modes or between different transit services convenient and seamless for users. It could also permit the gathering of better ridership data for transit operators and may produce a small reduction in fare processing costs. Smartcards could be particularly effective if used for employer subsidy programs and for providing discounts to frequent transit users.

Related Projects:
Smartcard Fare Collection Test, Delaware
San Francisco Multimodal Fare Payment Media
Twin Cities Smart Traveler Project
Chattanooga Smart Card Study, Tennessee

Table 31. In-vehicle information displays.

Project Title: Providing In-Vehicle Information Displays for Transit

Related Scenario: #7 - Transit Vehicle Information Displays

Applicable Mode(s): P = Primary S = Secondary

____ Highway	_P__ Paratransit	____ Airport
S___ Transit	____ Port	

IVHS Functional Area(s):

_____ ATMS	P___APTS	____ AVCS
P___ ATIS	____ CVO	

Area(s) of Applicability:

P Large Urban	P Medium Urban	S Small Urban	__Rural

Description: On-board and at-stop information displays could provide transit users with information on bus location, the location and status of connecting buses, and other schedule data.

Related Projects:
Various Bus AVL Systems
Real-Time Transit Information, New York MTA
Houston Smart Traveler

Table 32. Real-time ridesharing.

Project Title: Real-Time Ridesharing

Related Scenario: #ll - Real-Time Ridesharing

Applicable Mode(s): P = Primary S = Secondary

_P__ Highway ____ Paratransit ____ Airport

S___ Transit ____ Port

IVHS Functional Area(s):

_____ ATMS S___APTS ____ AVCS

P___ ATIS ____ CVO

Area(s) of Applicability:

P Large Urban S Medium Urban S Small Urban S Rural

Description: Test the feasibility and utility of providing real-time ridesharing services. Among issues to examine are legal ramification„, safety and security questions, liability issues, and overall system effectiveness. Other questions include: What is the "critical mass" of participants for such a system to be useful? What are the best incentives to encourage use? How much and what types of travel can be expected to be captured by such a system?

Related Projects: Bellevue, WA Smart Traveler
Minneapolis, MN Smart Traveler Project
Sacramento, CA Real-Time Ridematching System

Table 33. Real-time paratransit dispatching.

Project Title: Implementation of Real-Time Paratransit Dispatching

Related Scenario: #12 - Paratransit Dispatching

Applicable Mode(s): P = Primary S = Secondary

____ Highway _P__Paratransit ____ Airport

____ Transit ____ Port

IVHS Functional Area(s):

_____ ATMS P___APTS ____ AVCS

_____ ATIS ____ CVO

Area(s) of Applicability:

P Large Urban P Medium Urban P Small Urban P Rural

Description: This test would evaluate the effectiveness and practicality of real-time paratransit dispatching. It could evaluate the utility of different routing algorithms, the practicality of coordinating transfers, and overall system cost-effectiveness. This could prove to be a dramatic improvement over existing dispatch systems.

Related Projects: Winston-Salem, NC Mobility Manager
Rogue Valley, OR Mobility Manager

Table 34. Ride home services.

Project Title: Provide Guaranteed Ride Home Services Using Smartcards

Related Scenario: #13 - Taxi/User Side Subsidy with Smartcards

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway	____ Paratransit	____ Airport
____ Transit	____ Port	

IVHS Functional Area(s):

_____ ATMS	P____APTS	____ AVCS
_____ ATIS	_S__ CVO	

Area(s) of Applicability:

P Large Urban P Medium Urban S Small Urban P Rural

Description: A guaranteed ride home service would provide an ideal testing ground for the use of Smartcards to pay for user-side subsidy services. Employers would pay only for those trips used and would be able to keep detailed records of all uses and transactions.

Related Projects:
Southern California Smart Card
Twin Cities Smart Card
Delaware Smartcard Fare Collection Test

Table 35. Development of rural ATIS.

Project Title: Development of a Rural ATIS

Related Scenario: #15 - Rural ATIS/Route Guidance

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway ____ Paratransit ____ Airport

____ Transit ____ Port

IVHS Functional Area(s):

_____ ATMS ____ APTS ____ AVCS

__P___ ATIS ____ CVO

Area(s) of Applicability:

__ Large Urban __Medium Urban __Small Urban P Rural

Description: A rural ATIS could prove particularly useful for providingparatransit and special services in rural areas where direction finding can be difficult. This operational test should evaluate the costs and effort required to develop such a system, the feasibility of using portable ATIS units, and the optimum type of AVL equipment for rural areas.

Related Projects: None available.

Table 36. Real-time transportation information to highway users.

Project Title: Providing Real-Time Transportation Information to Highway Users

Related Scenario: #16 - Real-Time Transportation Information in Homes, Workplaces, and Stores

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway	____ Paratransit	____ Airport
__S__ Transit	____ Port	

IVHS Functional Area(s):

__S__ ATMS	__P__ APTS	____ AVCS
__P___ ATIS	____ CVO	

Area(s) of Applicability:

P Large Urban   P Medium Urban   S Small Urban   __Rural

Description: This scenario is similar to #2 described above. It would provide traffic information in real-time to highway users. This project would need to establish the level of coordination required between different agencies in order to make the system truly network-wide. This project would also need to determine the best methods and locations for relaying this information to users in a format that is accessible and easy to understand.

Related Projects: Houston Smart Traveler
Boston Smart Traveler
Dulles Corridor DATE, Northern Virginia

Table 37. Roadway condition monitoring.

Project Title: Vehicle-Based Roadway Condition Monitoring

Related Scenario: #19 - Weather/Roadway Condition Monitoring

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway ____ Paratransit ____ Airport

____ Transit ____ Port

IVHS Functional Area(s):

____ ATMS ____ APTS ____ AVCS

__P_ ATIS ____ CVO

Area(s) of Applicability:

S Large Urban S Medium Urban S Small Urban P Rural

Description: This scenario could supplement existing fixed arrays of weather sensors to provide more complete coverage of the highway system, particularly in rural areas. This test could evaluate the performance of various sensor designs and various methods for transferring data between vehicles and between a vehicle and a roadside receiver.

Related Projects: Storm Warning System Test, Idaho
Snoqualmie Pass, WA Safety Program

Table 38. Development of an airport/highway ATIS.

Project Title: Development of an Airport/Highway ATIS

Related Scenario: #23 - Airport Access/Passenger Pick-Up

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway ____ Paratransit _P__ Airport

____ Transit ____ Port

IVHS Functional Area(s):

__S_ ATMS ____ APTS ____ AVCS

__P_ ATIS ____ CVO

Area(s) of Applicability:

S Large Urban S Medium Urban S Small Urban P Rural

Description: Some airports already provide flight information to airport users via cable TV. This test would take the system one step further and provide updated flight information and guidance to motorists once they arrive at the airport. Several airport authorities have expressed an interest in some form of this scenario. This project should identify those services which would be most useful and most cost-effective to apply in the short term. It should also examine thelong term services that will be possible once more advanced in-vehicle communication devices become available.

Related Projects: None Available

Table 39. Improving truck access to ports and rail facilities.

Project Title: Improving Truck Access to Ports and Rail Facilities

Related Scenario: #24 - Truck Access to Ports/Rail Facilities

Applicable Mode(s): P = Primary S = Secondary

__P_ Highway ____ Paratransit ____ Airport

____ Transit _P__ Port

IVHS Functional Area(s):

_P__ ATMS ____ APTS ____ AVCS

__P_ ATIS _P__ CVO

Area(s) of Applicability:

P Large Urban P_ Medium Urban S Small Urban S Rural

Description: This project would test different methods to improve truck access to port and rail facilities. Dynamic route guidance, scheduling, and holding lots to handle overflows could enhance the operation of ports and their surrounding highway networks. The system could provide special route guidance for vehicles with hazardous or oversized cargo, distribute traffic more evenly throughout the day through advanced scheduling, and reduce congestion in the vicinity of the facility through the use of holding lots.

Related Projects: None Available

Table 40. Vehicle processing at ports and rail facilities.

Project Title: Enhance Vehicle Processing at Ports and Rail Facilities

Related Scenario: #25 - Improved Vehicle Processing at Ports/Rail Facilities

Applicable Mode(s): P = Primary S = Secondary

____ Highway	____ Paratransit	____ Airport
____ Transit	P Port	

IVHS Functional Area(s):

____ ATMS	____ APTS	____ AVCS
____ ATIS	P CVO	

Area(s) of Applicability:

P Large Urban	P Medium Urban	P Small Urban	P Rural

Description: Automated vehicle processing technologies such as AVI, weigh-in-motion (WIM) and AVL tracking could help to reduce delays experienced by truckers when entering ports and improve tracking and recordkeeping within the port itself. Several port authorities have expressed an interest in implementing some form of this scenario.

Related Projects: None Available

Table 41. Current operational tests (FHWA).

I. Traveler Information Systems

1. Smart Traveler (Boston)
2. Direct (Michigan)

II. Route Guidance and Navigation Systems

3. Advance (Illinois)
4. Fast-Trac (Michigan)
5. Pathfinder (California)*
6. Travtek (Florida)*

III. Transportation Demand Management

See Section C (APTS) for Houston Smart Commuter

IV. Traffic Control Systems

7. Connecticut Freeway ATMS
8. Genesis (Minnesota)
9. Satellite Communication Feasibility (Pennsylvania)
10. SMART Corridor (California)

V. Rural Applications

11. Travel-Aid (Washington)

VI. Commercial Vehicle Applications

12. Advantage I-75
13. HELP/Crescent (Arizona/California)
14. PASS (Oregon)
15. Michigan/Ontario Border Crossing (U.S./Canada)

* = Completed

Table 42. Planned operational tests.

1. San Antonio Advanced Traffic Management System Test (Texas)
2. Dynamic Truck Speed Warning for Long Downgrades (Colorado)
3. On-Board Automated Mileage/State Line Crossing Test (Iowa, Minnesota, Wisconsin)
4. Washington, DC Area Traffic Flow Measurement Test (MDSHA, VDOT, DC)
5. Minneapolis/St. Paul Personal Communication Device Test (Minnesota)
6. Integrated Freeway Ramp Metering and Adaptive Arterial Signal Control Test (California)
7. Mobile Communication System Test (California)
8. Adaptive Traffic Signal Control System Test (California)
9. Smart Call Box Test (California)
10. San Francisco Bay Area Intermodal Traveler Information System Test (California)
11. Spread Spectrum Radio Traffic Signal Interconnect Test (California)
12. Storm Warning System Test (Idaho)
13. Automated Truck Speed Warning for Freeway Ramps (Maryland/Virginia)

Table 43. ATIS program.

I. Smart Traveler

1. Seattle Smart Traveler (Washington)
2. California Smart Traveler (California)
3. Houston Smart Commuter (Texas)
4. Rogue Valley Mobility Manager (Oregon)
5. Travlink (Minnesota)*
6. Houston Smart Commuter (Texas)
7. Milwaukee Smart Bus (Wisconsin)
8. Bus Transit Travel Information Test (Colorado)*
9. Smartcard Bus Fare Collection Test (Delaware)*
10. NY City Metropolitan Transportation Authority Travel Information*
11. Fredericksburg ARTIS (Virginia)
12. Winston-Salem Mobility Manager
13. Delaware County Automated ID and Billing System
14. Denver Smart Bus Stage II (Colorado)

II. Smart Vehicle

15. Portland Smart Bus (Oregon)
16. Denver Smart Bus Stage I (Colorado)
17. Baltimore Smart Bus (Maryland)

III. Smart Intermodal Systems

18. Detroit Transportation Center Transit Information (Michigan)
19. Ann Arbor Smart Intermodal (Michigan)
20. Chicago Smart Intermodal (Illinois)
21. Southern California Smart Card (California)

IV. Program Evaluations and Research

22. Twin Cities Smart Card (Minnesota)
23. Traffic Management Information and Fleet Operation Coordination (California)
24. IVHS Institutional Issues (George Mason University)
25. Advanced Fare Payment Media II (Diamond Bar, California)
26. Transit Network Route Decision Aid (Michigan)
27. Operational Test Evaluation (TSC - Mass.)
28. Technology Research (Volpe - Mass.)
29. Flexibly Operated Transit (University of Pennsylvania)
30. Chattanooga Smartcard (Tennessee)

* = Planned Operational Tests

Table 44. Transit agencies procuring AVL systems.

1. Seattle, Washington
2. San Mateo, California
3. Denver, Colorado
4. San Antonio, Texas
5. Dallas, Texas
6. Twin Cities, Minnesota
7. Kansas City, Missouri
8. Milwaukee, Wisconsin
9. Chicago, Illinois
10. Champaign-Urbana, Illinois
11. Cheboygan, Michigan
12. Traverse City, Michigan
13. Ann Arbor, Michigan
14. Beaver County, Pennsylvania
15. Baltimore, Maryland
16. New Jersey Transit
17. Norfolk, Virginia
18. Jacksonville, Florida
19. Tampa, Florida
20. Palm Beach County, Florida
21. Fort Lauderdale, Florida
22. Miami, Florida

5. RESEARCH AND DEVELOPMENT NEEDS

This section presents scenarios that hold the potential to provide significant benefits, but require additional research and development before operational testing or implementation takes place. These scenarios were selected based on evaluations performed in task B, and feedback from the task C presentation and the task D site visits. They represent projects that attracted interest from transportation community, but due to certain barriers or uncertainties over the magnitude of benefits they would provide were deemed to require further investigation and evaluation. Recommendations for future research and development programs to provide this information are presented here. The R&D recommendations are presented in the format of project descriptions. Each project description states the objectives of the project, its modal applications and IVHS functional area(s), its potential benefits, and a brief description of its relevance to scenarios described in this report.

SCENARIOS REQUIRING FURTHER RESEARCH AND DEVELOPMENT

The scenarios that were judged promising but in need of further development are:

- Transit Priority on Signalized Networks (#6).
- Automatic Accident Data Recording (#10).
- Urban Goods and Passenger Movement (#14).
- Air Pollution Alert (#18).
- ATIS: Parking Availability (#20).
- Personal ATIS Unit (#21).
- River and Drawbridge Coordination (#26).

OTHER SCENARIOS

There are additional scenarios described in section 2 that are not recommended for operational testing or further research and development. These scenarios are not without merit, but the feedback from the workshops indicated that they were either too specialized (i.e., suitable for only a few specific types of environments) or faced very serious institutional barriers. Some localities may nonetheless find one of these scenarios, or a variation thereof, applicable to their area. These scenarios are listed below along with brief descriptions of why they are not being recommended for further development:

- Timed Transfer Management (#3) - Many transit operators at the workshops felt that this scenario could be performed just as well with conventional radio equipment, and thus saw the additional benefits from IVHS technology as limited. As AVL equipment becomes more common in transit vehicles, though, one may expect that this scenario will be integrated into location monitoring and scheduling systems.

- Transit Park & Ride Space Reservation (#4). - This scenario did not receive very much enthusiasm at any of the workshops. The most common objection was that space reservation at transit lots is unequitable and too complex to manage effectively. Regular transit riders, it was argued, know when parking is or is not available and do not need such a system. A simplified system might simply broadcast information on parking availability via cable TV to homes and workplaces.

- Transit Schedule Reliability (#8) - This scenario was seen by many workshop participants as having too limited an application for widespread implementation. Most transit agencies could not afford to keep extra buses on standby, to be called into service only during severe congestion. It may still have applications in cities like Los Angeles where a schedule reliability program is already in use and might benefit from IVHS technology.

- Improved Transit Management Information (#9) - Some types of vehicle monitoring systems are already in use by many transit agencies. The additional types of information provided by more advanced systems (driver performance data, real-time breakdown warning) were seen by many at the workshops to be of only limited utility to transit operators. The driver performance data, in particular, also held the potential for serious conflicts with drivers over issues of privacy.

- Needs Scheduling (#17)- Some workshop participants liked this scenario in concept, but felt that there were too many institutional barriers to overcome. Most stores and businesses would not be Willing to have any potential customers diverted away to other shopping centers, and it was felt that people's shopping habits would be difficult to change. The potential benefits of this scenario were seen as too uncertain to warrant further development.

- Traffic Management at Parks and Monuments (#22) - This scenario was seen to have very limited applications and could probably be carried out on a smaller scale without using IVHS technologies. Some saw this scenario as an example of trying to force an IVHS solution into a situation where it really is not warranted. Nonetheless, this scenario may have applications in some national parks and in urban tourist centers, such as the Washington, DC core area.

- Moving Urban Goods on Ferries (#27) - This scenario, too, was seen as having very limited applicability. It may yet find a niche in cities like New York and Seattle, where ferries are used for transport, but it would likely have to be carried out by private firms and only in areas where the benefits in terms of reduced delays would clearly justify the costs.

OTHER RESEARCH AND DEVELOPMENT NEEDS

Along with research into the feasibility, utility, and costs of specific multimodal scenarios, the feedback from the site visits indicated that there needs to be additional research into the methodologies that will be used to evaluate these scenarios. While principles for the evaluation of transportation management strategies and IVHS have been developed by a number of key resource groups (USDOT, FTA, IVHS America), there are at present no specific guidelines or procedures for the evaluation of multimodal IVHS projects and operational tests. These evaluations will be critical in determining the ultimate success of the multimodal IVHS program in this country. Guidelines will be needed for the evaluation of IVHS projects at the program level, at the design level, and at the operational test level. Each of these three areas are discussed below.

Conceptual Planning/Program Evaluation

Responsive multimodal transportation management and IVHS will require broad evaluation frameworks to aide in concept development, plans (national, State, and local), and programs. At the national level, IVHS benefit issues such as congestion, safety, energy, environmental impacts, economic productivity, social impacts, and institutional impacts will need to be addressed. A process will be needed for linking responsive multimodal transportation management to IVHS, such as the one developed for this project to develop and refine the 27 functional scenarios.

At the State and local levels, evaluation frameworks are critical in the development and adoption of strategic plans dependent on cost effectiveness considerations. There were many comments on this during the site visits which included:

Early Benefit/Cost Effectiveness Results

Many participants expressed an interest in obtaining some notion of cost effectiveness even if it was based on "back of the envelope" or expert panel "impressions." Planners in particular needed this so that these type of projects could be discussed with decision makers and included in State, local, and private plans, such as TIP's, Capital Improvement Programs, Corporate Plans, etc. The early results could help in determining applicability and screening activities so that "promising" scenarios could be advanced forward.

Flexibility in Scenario Implementation

Participants expressed a desire to use greater flexibility in implementing scenarios which addressed problems. In certain cases, a scenario might be dissected and evaluated in incremental steps. This was the case for areas with little IVHS infrastructure. Areas with more mature IVHS infrastructure saw possibilities for combining or packaging the scenarios. Regardless of the IVHS maturity, all felt it was better to start with small "successful" steps before jumping into more extensive deployments and evaluations.

Technical Information Dissemination

Since the project's inception there has been a flurry of activity, technological developments, new deployments, operational tests, etc. Practitioners wanted a reliable central clearinghouse where they could obtain information on operational test evaluation results and practices related to Multimodal Transportation Management and IVHS. A range of approaches were discussed -- all involving public, private sector, and university cooperation and involvement. The goals were to access organized information on:

- Which scenarios were being tried.
- Which ones did and did not work.
- The limitations for various applications.
- The net public benefits and costs.
- The private sector concerns.
- Responses from various market segments.

- Who was conducting the work.
- The status of various projects.
- What partnership arrangements were involved.

Specific Comments

Specific comments were also provided on the individual scenarios, the conceptual evaluations, and the evaluation framework. The participants felt that scenarios aimed at meeting functional needs and goals matched with appropriate IVHS advanced technologies were the preferable way to go. Many felt that technology driven solutions would be an inappropriate approach. They also felt that existing available technologies should be considered along with the IVHS packages, and cost effectiveness considerations should drive the selection by State and local governments. The participants refined the conceptual evaluations and endorse the criteria and framework used in the evaluation.

User Segmentation

Many felt that the benefits and costs should be separated by the groups affected: transit operations, traffic operations, airport operations, users, society as a whole, etc. One of the key findings was that user (market) segmentation was critical in the early operational test evaluations. Scenarios aimed, for example, at unfamiliar tourists may be appropriate in an area while the same scenario may not be appropriate or cost effective for familiar travelers in that area.

Design Evaluation

Once a multimodal transportation management/IVHS concept, plan and program of projects are identified there is a need to consider benefits, evaluations and costs at the project design stage. At this point there is a need to be quite specific on goals, objectives, and specific measures of effectiveness (MOE's). More importantly, a cost effectiveness approach is needed which may include packages of advanced IVHS technologies and more traditional technologies.

At this project stage it is also important to deal with information management, institutional change, and legal concerns as follows:

Information Management - There is a need to better manage multimodal real-time and semireal-time information. Issues include concerns for quality control, rules for data distribution to the public. There is also concern about the roles and responsibilities of the public and private sector in management of the information and evaluation results.

Institutional Issues - Present administrative, legal, and funding mechanisms would need to be changed to accommodate responsive multimodal transportation management strategies. Administratively, many State and local staffs are organized along mode specific lines such as traffic operations, transit operations, paratransit dispatching, etc. There is also a need to dedicate staff to provide administrative mechanisms which fostered communications on how to provide responsive multimodal information systems, etc., using IVHS advanced technologies.

Legal Concerns - Modification of laws in certain areas that could be obstacles for deployment of responsive multimodal transportation management strategies (TMC's), IVHS infrastructure, communication systems, etc.

In conducting these project level evaluations behavioral issues would need to be considered including:

- IVHS system effects are often defined in behavioral terms.
- Variability is inherent in the measurement of behavioral effects.
- Looking for practical effects which satisfy functional goals.
- Addressing exposure.
- Developmental vs. operational testing.
- Need to define functional performance goals.
- Clarifying "user acceptance" as an area of human factors evaluation.
- Evaluation focus on system operators and maintenance and not solely vehicle operators.

At the project level benefits, costs, and effects will need to be related to real-world limitations on how the data collection can be conducted so as to maintain traffic flow and provide for safety concerns. Best available simulation models may be applied as opposed to more theoretically elegant models. A good synthesis of the results will be needed for use by administrative engineers, planners, and managers.

Operational Evaluation

At this stage of implementation, evaluation frameworks for monitoring, surveillance, and operational evaluation have been established by Federal agencies, particularly those related to operational tests. An Evaluation Methodology developed by FHWA/MITRE provides five phases of operational evaluation: (1) operational test definition, (2) evaluation definition, (3) evaluation design, (4) evaluation performance, and (5) reporting. The procedures, although generic, provide guidance on what is expected for evaluation for operational test projects using Federal funds. These evaluation procedures would apply to ATMS, ATIS and CVO technologies. The products would be developed by the various participants including partners, FHWA, the Evaluation Team, and the Project Evaluator. The FTA has also developed guidelines for assessment of transit related projects. These are documented in "Evaluation Guidelines for the Advanced Public Transportation System Operational Tests, Draft." Depending on the issues, these procedures might also be expanded to monitoring and surveillance activities.

Many of the evaluations at the operational level can omit evaluation considerations during monitoring and surveillance activities for a responsive multimodal transportation management strategy. This omissions can miss the ability to reach conclusions on safety, for example. Since accidents are statistics of rare events, 2-to 3-year data collection efforts may be necessary to reach conclusions on accident/severity reductions associated with IVHS related deployments. Without such rigorous experimental work, safety considerations would have to be inferred from indicators such as conflict reduction, collision avoidance, and observations.

Summary

While some good principles exist for the evaluation of multimodal IVHS projects, additional work needs to be done to incorporate them into firm guidelines that can be used at the national, State, and local levels. Feedback from the site visits indicated that program administrators need more specific guidelines to evaluate projects at the conceptual/program level, during the design phase, and during the operational test phase. These evaluation guidelines should be incorporated into all future operational test activities.

R & D Project Description

Project Title: Evaluation of Network-Wide Signal Optimization for Transit and High Occupancy Vehicles

Related Scenario: #6 - Transit Priority on Signalized Networks

Objectives: Evaluate the potential benefits of network-wide signal priority for buses and high occupancy vehicles and identify any technical hurdles that would have to be overcome.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway	_S_	Paratransit		Airport
_P_	Transit		Port		

IVHS Functional Areas:

	ATIS		AVCS	_P	APTS
_P_	ATMS		C V O		ARTS

Potential Benefits: Potential benefits of this scenario could include reduced delays for transit vehicles, improved ridership, and reduced operating costs through reduced fleet requirements. Potential drawbacks could include negative impacts on the flow of other types of traffic.

Description: This type of scenario may lend itself well to a preliminary evaluation using a traffic simulation model such as TRAF-NETSIM. Such models may at least yield rough estimates of the amount of delay reduction that could be expected for transit vehicles and the size of delay increases for other traffic. Special attention would need to be paid to bus stop locations, dwell times, passenger boarding times, and the effects on side-street traffic. The research should also examine the different types of technologies that could be used to identify transit and HOV vehicles in the traffic stream and the algorithms that would he used to determine whether a bus was on or behind schedule and give priority to its movement. The research should also examine the results obtained in Europe where bus priority routes have been tested.

Estimated Level of Effort: 1____ person-year

R & D Project Description

Project Title: Automatic Accident Data Recording for Transit Vehicles

Related Scenario: #10 - Accident Data Recording

Objectives: Develop methods of recording accident and passenger data to prevent false claims against transit agencies.

Modal Applications (P - Primary, S - Secondary)

_S_	Highway	Paratransit	Airport
_P_	Transit	Port	

IVHS Functional Areas:

ATIS		AVCS	_P_	APTS
ATMS	S	CVO		ARTS

Potential Benefits: The main benefit of this scenario would be a reduction in the number and amount of accident claims filed against transit operators. This research would determine if these savings would justify the costs of installing such a system. It would also identify the most appropriate technologies to be used.

Description: The technologies exist today to provide transit vehicles with a "black box" similar (in concept) to those used on commercial airliners. An on-board computer could record vehicle and driver performance data such as speed and brake use at the time of the accident. The most difficult task would be to record passenger data, either through the use of smartcards, or by means of an on-board camera which would take a snap-shot of the interior of the vehicle at the time of the accident. Testing should be performed to determine if this is a realistic means of obtaining this data, and if so, would the benefits justify the costs.

Estimated Level of Effort: _____ person-year

R & D Project Description

Project Title: Urban Goods and Passenger Movement

Related Scenario: #14 - Urban Goods and Passenger Movement

Objectives: Determine the feasibility of using courier vehicles to transport people as well. Specifically, determine what the market demand would be, the specific institutional and permitting issues, and the potential benefits in terms of reduced congestion and increased profitability for courier services.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway	Paratransit	Airport
	Transit	Port	

IVHS Functional Areas:

ATIS		AVCS	APTS
ATMS	_P_	C V O	ARTS

Potential Benefits: The benefits of this research would be to provide courier companies with a credible assessment of the feasibility of this scenario.

Description: This scenario has some very attractive features and significant potential benefits; however, there are many questions as well. What are the insurance, permitting, and regulatory requirements for operating such a service? How many passengers can be expected to be served? How much additional revenue could be generated for courier companies? All of these questions need to be answered before courier companies can be expected to invest in such a scenario. Ideally, the outcome of this research would be a detailed operational test and evaluation plan.

Estimated Level of Effort: 1____ person-year

R & D Project Description

Project Title: Multimodal IVHS Strategies to Respond to Air Quality Alerts

Related Scenario: #18 - Air Quality Alert

Objectives: Determine the potential for IVHS technologies to reduce mobile emissions during air quality alerts.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway	Paratransit	Airport
_S_	Transit	Port	

IVHS Functional Areas:

_P_	ATIS	AVCS	APTS
_P_	ATMS	CVO	ARTS

Potential Benefits: The potential benefits of this research would be refined scenarios for reducing the severity of air quality alerts.

Description: The ability to change travel patterns during air quality alerts would be very useful to traffic managers in urban non-attainment areas; however, many questions need to be answered before such a scenario could be implemented. How could travel patterns be monitored (AVI tags, smartcards) and how could drivers be billed for their travel? How would pollutant levels be monitored and how would they be tied to auto travel patterns? Air emissions models could be used to simulate some of these scenarios and at least gain order of magnitude estimates of their impacts on air quality. This research should yield a detailed operational test and evaluation plan for testing this scenario in a non-attainment area.

Estimated Level of Effort: __2__ person-years

R & D Project Description

Project Title: Providing Real-Time Information on Parking Availability

Related Scenario: #20 - ATIS: Parking Availability

Objectives: Assess the feasibility of providing real-time information to motorists on parking availability and location.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway	Paratransit	Airport
	Transit	Port	

IVHS Functional Areas:

_P_	ATIS	AVCS	APTS
_S_	ATMS	C V O	ARTS

Potential Benefits: The potential benefits of such a scenario would be greater convenience for motorists looking for parking for commercial deliveries, special events, or just normal traffic conditions. Such a system could help ease congestion in CBD's and promote better utilization of parking facilities in congested areas.

Description: A parking availability service was considered as part of the Trav-Tek operational test program, but was dropped because of inherent difficulties. This type of system could prove useful as one module in a comprehensive in-vehicle ATIS system. This research would be aimed at assessing the feasibility of providing real-time parking information and assessing some of the functional requirements such as how parking availability would be monitored, how providers would ensure that a space is still available when the motorist arrives, and the types of parking information that will be provided (e.g., surface lots, garages, on-street parking, and commercial loading areas). The research would yield functional specifications and protocols for a parking information system.

Estimated Level of Effort: __2__ person-year

R & D Project Description

Project Title:	Feasibility of a Personal ATIS Unit
Related Scenario:	#21 - Portable ATIS System
Objectives:	Determine the feasibility of a personal ATIS unit which not only provides static information on route selection, transit routes, and traveler services, but also provides real-time traffic information, real-time transit schedules, and location information.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway	Paratransit		Airport
_P_	Transit	Port		

IVHS Functional Areas:

_P_	ATIS	AVCS	_P_	APTS
_S_	ATMS	C V O		ARTS

Potential Benefits:	A personal ATIS unit could provide the same services to the pedestrian and transit rider that in-vehicle ATIS systems provide to drivers.
Description:	Some portable ATIS devices that are available today provide static information including maps, route planning, traveler services, and fixed transit routes. A more advanced unit could provide real-time information on traffic conditions, transit schedules, user location, and dynamic route guidance. The Genesis portable ATIS system is currently being developed and tested in Minnesota. Such a system would also be an appropriate element of the Bay Area IVHS System under development.

Estimated Level of Effort: 2 person-years

R & D Project Description

Project Title: Institutional Issues Related to the Coordination of River and Drawbridge Traffic

Related Scenario: #26 - Real-Time Coordination of River and Drawbridge Traffic

Objectives: Examine the institutional and cooperative arrangements required for the effective real-time coordination of river and drawbridge traffic.

Modal Applications (P - Primary, S - Secondary)

_P_	Highway		Paratransit	Airport
	Transit	P _	Port	

IVHS Functional Areas:

_P_	ATIS		AVCS	APTS
_P_	ATMS	S _	CVO	ARTS

Potential Benefits: The real-time coordination of bridge and water traffic could prove useful in congested areas where bridge openings can create severe delays for motorists. This type of situation exists in urban areas such as Washington, DC (Woodrow Wilson Bridge) and Chicago (Chicago River bridges) and could be ameliorated through the use of bridge and water traffic management systems.

Description: The type of traffic coordination described in the scenario, however, will require unprecedented cooperation between traffic operations and those agencies that control travel on our Nation's waterways. It would be useful to hold informal workshops with the key stakeholders in potential test sites around the country to discuss the utility of such a scenario and the types of issues that will need to be addressed if implemented. The study could then identify the most promising sites for operational testing based on potential benefits, costs, the suitability of the area, and the willingness of local stakeholders to cooperate.

Estimated Level of Effort __0.5__ person-year

APPENDIX A. DETAILED SCENARIO EVALUATIONS

SCENARIO 1 - ROUTE DEVIATION
DYNAMIC STOP REQUESTS AND ROUTING

Description

Checkpoint route deviation, in which a bus operates on a fixed route always stopping at selected locations but also deviating a set distance off the service route to origins and destinations within the route corridor, has been proposed and tested as a means to make service more convenient in low-density suburban and rural areas without incurring the costs associated with point-to-point dial-a-ride. The need to always service each checkpoint has made such services too costly and inefficient for general application. Furthermore, since it is difficult to maintain a schedule with such service, those boarding at stops have not been assured of reliability. The need under ADA to provide door-to-door service for ADA eligible riders within a three-quarter mile corridor on either side of fixed routes suggests that route deviation could permit full service to all users without duplicating services. Route deviation service could also be provided during off-peak hours to allow for the use of fewer vehicles. When combined with AVL and in-vehicle ATIS systems, route deviation could prove to be a realistic and effective means of supplying these services. Under this scenario, users would request route deviation service either from homes or businesses, or from at-stop call units. To prevent abuse at these stops, the units would be activated by a smartcard or a partial fare. A dispatch center would automatically verify eligibility, compute the optimum routing (skipping non-requested stops), and direct a bus to the pick-up point through an ATIS display. Upon boarding, passengers could enter their destinations via touch-screen display, and a refined routing would be automatically computed. Displays at stops and in homes could provide real-time bus location information to users.

Potential Benefits

Such a system would reduce vehicle-miles and vehicle-hours traveled with the potential for providing faster, more direct service for passengers. System benefits would be greatest in low density areas and during off-peak operations when it could permit the use of fewer vehicles. The system may also allow transit operators to provide effective route-deviation service for ADA eligible riders without having to provide duplicate services. The system could also prove very effective in providing transit service in small urban and suburban areas.

Potential Costs

When combined with existing AVL and in-vehicle ATIS and guidance systems, the incremental cost of implementing such a system should be moderate. For maximum effectiveness, the system would require information displays on vehicle status at the fixed point stops so that riders could know when the next bus was arriving. The cost of deploying at-stop units could be high, depending on the number and type used.

Institutional/Legal Barriers

Institutional and legal barriers should be few. Some jurisdictions may consider this to be cab or charter service, and regulations may have to be altered to accommodate it.

Financial Feasibility

This type of system has been successfully demonstrated in Germany (FOCCS). The provision of route deviation service could allow transit agencies to reduce operating costs while improving service. The costs of widespread installation and maintenance of bus stop information displays may be prohibitive in some areas.

Attractiveness to Users. Operators, and Society	Users should find this type of service attractive both for the added convenience of deviation service and the increased flexibility over conventional paratransit service. Operators will need to adjust to frequent route deviations, but in-vehicle route guidance should vastly simplify that task. The system offers a cost-effective means of meeting the requirements of the ADA and for reducing operating costs during off-peak times.
Human Factors Effectiveness	At-stop request units and information displays will need to be easy **to** use and understand. Phone requests could be handled by an automated system using voice menus or voice synthesis. The system should verify the user's request and give an approximate time for bus arrival based on real-time vehicle location data. Route deviation users would most likely need to be registered to avoid abuse of the system and could be assigned a personal I.D. number to help verify this. The use of smart cards would make this scenario even more efficient both for verification of eligibility and ease of payment. Some training would be required on the part of operators.
Potential for success	The potential for success should be high, especially when used for providing ADA services. It could be a cost-effective alternative to providing overlapping point to point dial-a-ride service.
Imdementation Potential	AVL and central dispatch systems will need to be in place before implementation of route deviation service can occur. Systems may have greatest applicability to small urban and suburban areas, Route deviation may be of more limited use in large urban areas or on high volume transit routes.

Description	The lack of reliability in bus services combined with user uncertainty regarding the fact that a bus will actually arrive on schedule contribute to an unwillingness to use offered services. A real-time bus position and arrival information system would provide users and operators of transit systems with better information about the status of buses and trains. The system could provide riders with information on transit arrivals, transfers, and would allow users to adjust their schedules in the event of delays to vehicles due to congestion or an incident. In this system, real-time information on bus location and expected arrival time at user specified bus stops would be provided at bus stop displays, residences via dial-up telephone, cable TV, computer, or videotext services, and in offices via dial-up computer terminals. Providing users with real-time bus position and arrival information should promote ridership and make the system more convenient and safer for riders to use.
Potential Benefits	The system could provide reliable up to the minute information on transit status to users in homes, businesses, commercial centers, and at transit stops. The availability of this information would reduce uncertainty associated with transit usage and could potentially increase ridership, It would also allow passengers to go out and meet the bus at just the right time, which is not only a convenience, but a potential safety benefit as well. The system would also allow operators to monitor vehicle status.
Potential Costs	Providing transit information at homes, businesses, commercial centers, and at major transit centers could probably be done in a cost-effective manner through the use of cable TV and computer networks. Providing real-time information at selected transit stops could prove very expensive to install, maintain, and protect from vandalism. Overall cost of operation will depend on the number and type of information displays provided.
Institutionsl/Legal Barriers	Implementation of such a system may require some institutional agreements but they should not present significant barriers. Transit companies may need to work out an agreement with local cable TV operators to permit broadcast of the information to homes and businesses. Transmission **of** information could be done directly by the transit operator or through a local TMC. Transit operators may also need to work out agreements with property owners for placement of displays/terminals in businesses and commercial centers. There would be few, if any, legal barriers to such a system.
Financial Feasibility	Depending on the extent and type of implementation, financial feasibility could range from questionable to high. The transmission of transit information to homes, offices, major shopping centers, and transit centers could most likely be accomplished at reasonable cost. Many information centers could be subsidized through advertising or subsidies provided by employers and businesses. Transmission of information to homes could be covered by small user fees. The widespread implementation of information displays at bus stops could prove more difficult. Costs for implementation and maintenance might have to be subsidized by an outside source.
Attractiveness to Users, Operators, and Society	The system would be attractive to users in that it would provide them with more up to the minute information. Operators are already installing AVL systems and should find the basic information package attractive. Some operators may find network-wide implementation, especially at bus stops, as a substantial expense for the benefits provided.

Human Factors Effectiveness

Users would need to learn how to access and use data. The use of video displays and videotext systems would probably be the most effective from a human factors standpoint. Smaller transit systems could even use non-interactive displays and just cycle through the entire system once every few minutes – a potential cost savings. Larger systems would most likely have to use either interactive displays or break the network down into smaller units as the entire system would take too long to cycle through. Vandalism of on-street displays is a potential problem.

Potential for success

Would work well and could be fairly cheap to operate if the operator already has an AVL system in place. Could be combined with other information systems to provide users with printouts of transit information.

Implementation Potential

This type of system has been successfully operated in Ann Arbor, MI. Many operators, however, are currently not enthusiastic about these systems. Some financial support or operating subsidies may be required for implementation to be effective.

SCENARIO 3 - INTERMODAL CENTER TIMED TRANSFER MANAGEMENT

Description	Transit operators have found that the traditional, radially-oriented fixed route systems can not efficiently serve the dispersed origin-destination patterns of suburban development. To provide the necessary connections, many systems are implementing route structures in which many routes focus on a single transit center. Trips on all routes are scheduled to arrive at the transit center at the same clock time so that riders may conveniently transfer between routes and modes. Since timed transfer requires vehicles from all modes to be at the transit center at the same time, operators find that they must allot additional time in their schedules to accommodate unexpected delays, thereby increasing service costs. The proposed system could monitor real-time vehicle position information and allow the dispatcher to advise other vehicles to either wait or speed up if, for example, a train is delayed. Alternatively, a dispatcher could contact alternate modes (taxi, limousine, etc.) to meet delayed passengers. The system could also provide updated schedule information to passengers through displays in stations, stops, and in homes and businesses.
Potential Benefits	The benefits of such a system would be improved Schedule reliability, reduced slack time and improved operating efficiency on timed transfer routes, and improved information provided to passengers. This system would also allow the decision-making process to be centralized in the hands of the dispatcher.
Potential Costs	Little additional equipment would be required if an AVL system and radio dispatch system or in-vehicle ATIS were already in place, so the incremental installation and operating costs would be fairly low. The provision of updated schedule information could be done through telephone, cable TV, and videotext display systems, and could be provided directly by the transit agency or through a local TMC.
Institutional/Legal Barriers	This system assumes a link with the local TMC so that traffic and transit information can be exchanged.
Financial Feasibility	Financial feasibility is very high if an AVL system is already in place. Little additional equipment would be required outside of an electronic link with a TMC to provide real time traffic and congestion information.
Attractiveness to Users. Operators. and Society	For users, attractiveness would be high. The system would increase user confidence that transfers would be made and would provide users with up to the minute schedule information. Attractiveness to operators would also be high. Operators could potentially provide greater coverage at less cost. For society it is a low-cost means of upgrading transit service.
Human Factors Effectiveness	Little training required for operators of the system. lnformation displays should be clear, easily accessible, and easy to understand.
Potential for success	The operating principle behind such a system has already been demonstrated using simple radio dispatching techniques. Real-time AVL and ATMS will enhance this capability at a fairly low cost.
Implementation Potential	Implementation potential should be high. AVL systems are a natural first step for transit agencies to enter IVHS. Many AVL systems are being implemented across the country. This is an effective use of this new capability.

SCENARIO 4 - TRANSIT PARIS & RIDE INFORMATION AND SPACE RESERVATION

Description

A major impediment to the use of park & ride lots for bus and rail transit systems can be the uncertainty about being able to get a parking space at the lot. In this scenario, IVHS technology could be used to eliminate this uncertainty. Drivers could obtain information on parking availability at park & ride and private lots via telephone, videotext, or interactive cable TV displays. The driver could then reserve a space at the desired lot or at another lot if the first selection is full. The system would reserve the space and if the driver did not arrive within a certain time period, would request a reconfirmation either via in-vehicle ATIS or cellular telephone. The space could then be held or released. Smartcards could be used for payment. Drivers would be charged a fee for spaces reserved but not used. The goal of a transit park-ride information and space reservation system would be to increase transit usage by facilitating parking at transit centers. Variants of this system could give parking priority to rideshare vehicles or could be used at "good Samaritan" lots for handling additional demand during air quality alerts or special events.

Potential Benefits

The benefit of such a system would be increased transit usage and more efficient use of transit parking resources. Lack of sufficient parking at transit stops is a major disincentive to transit use. This would be a true demand management system since it could also direct drivers to empty lots and under-used facilities. It would also be of use during air quality alerts and special events.

Potential Costs

Potential costs of such a system if integrated into an already mature IVHS environment could be fairly low. Computer controlled equipment could monitor the availability of spaces at parking lots and handle all reservations automatically. Reservation fees could be charged to cover the costs of implementation and operation. It could initially be set up as a manual system with automatic computer monitoring added later.

Institutional/Legal Barriers

It would require a contract allowing the transit agency or parking lot operator to assess charges for spaces not used. It may also require some type of legislation absolving the operator of responsibility if a reserved space is not available. Otherwise, institutional and legal barriers should be fairly low.

Financial Feasibility

Parking and even additional reservation fees could cover the cost of implementation and operation. Parking availability information could easily be combined with other transit information services, such as real-time schedule information, so the incremental cost would be fairly low.

Attractiveness to Users, Operators, and Society

For users of the system, attractiveness could be high. It would allow drivers to be sure that there was a parking space available at the transit station before beginning their journey. For operators, attractiveness could also be fairly high. This system would allow the operator to direct users to under-used lots, provided lots were located close enough together to make trip diversions reasonable. Some users, however, may feel that the existing "first-come-first-served" system is more equitable. This system may also discriminate against people who do not have an in-vehicle ATIS system, although space reservation could also be done by cellular phone. From society's perspective, this system would be fairly attractive if it encouraged greater transit use.

Human Factors Effectiveness

This system could be similar to many existing automated reservation systems. Making reservations could be a fairly simple and straightforward process using either a touch-tone phone or an in-vehicle ATIS system. The user would simply key in the location of a desired lot and would be informed of parking availability and alternate sites, if necessary. There will need to be a high degree of system credibility, for travelers who arrive at a station only to find space unavailable will quickly lose confidence in the system.

Potential for success

The potential for success could be fairly high given the right conditions. In areas where transit parking demand exceeds supply, such a system would provide a useful service for a fairly low implementation and operating cost. System use would be fairly easy from a human factors standpoint.

Implementation Potential

Fairly high in certain areas but less so in others. The system would have greatest applicability in large urban areas where a lack of parking is a major disincentive to transit use. Implementation potential would probably be less in lower density areas where parking problems are less severe.

SCENARIO 5 - SMARTCARD FARE COLLECTION

Description

In areas where there are multiple transit operators and multiple service types, fare payment often becomes complicated. One way around this problem is the use of a pre-paid monthly pass good for use on several modes. Pass use, however, provides little or no information on ridership patterns and makes fare allocation among multiple operators difficult. Further, users are often reluctant to buy passes unless they are offered at a substantial discount and they can be sure that their use of transit will exceed the cost of the pass. Smartcard fare collection offers the opportunity for the automated and accurate recording and allocation of fares based on travel time, distance, or other factors (e.g., senior citizens and handicapped) across a variety of modes and operators. Further, as a marketing incentive, the system can be programmed to offer discounts to frequent riders based on the number of rides taken in a given period. Frequent riders are rewarded, but those whose riding patterns vary know that they will not pay more than the sum of the cash fares.

Potential Benefits

The use of smartcards will provide benefits to both users and operators. Smartcards will simplify fare payment for users and allow for much easier intermodal travel. Fares can be based on distance traveled rather than flat rates. In one test in Germany, the use of smartcards and distance based fares was actually found to increase ridership because users saw this system as being more equitable. Transit users will no longer be required **to** carry exact change and fare collection upon boarding should be speeded up. For transit operators, smartcards could permit more efficient fare collection and reduce handling costs. It will encourage travel between different modes and allow for the equitable distribution of fares between agencies. It will allow for collection of detailed ridership data. It could also be used as a marketing tool by offering specials fares and discounts for frequent users.

One area of transportation management that could benefit greatly from smartcards is the provision of employee subsidies for transit use. Employers are often reluctant to offer transit subsidies because they must pay flat subsidy rates and can not be assured that their employees are actually using transit enough to justify that amount. Smartcards would permit transit agencies to charge employers subsidies only for those trips actually taken by employees. Such a system should encourage more employers to participate in these programs.

Potential Costs

Smartcards themselves are much more expensive than conventional magnetic stripe farecards or flash passes. Currently smartcards cost $6 or more each, and even with anticipated reductions in this price they may still be considered too costly for lower or fixed income riders without subsidies. The system will require smartcard readers on all vehicles, and a central billing facility to download fare information and distribute funds between agencies. Some form of cash handling may still be needed.

Institutional/Legal Barriers

Multimodal smartcard systems will require cooperation among the various transportation providers. Operators will have to agree upon standards for the technology and on payment and reimbursement methods. User payment will most likely be from pre-paid accounts, but could be billed post-use for selected users. Operators will need to introduce some anti-fraud measures. Because the system can record the movements of individuals, and probably will need to for billing purposes, privacy is a concern, but questions of privacy can be easily addressed with adequate security measures.

Financial Feasiliility	Smartcards have already been fndorsement tested on a limited scale in Europe and in Japan. After initial installation costs, operating costs should be low, and perhaps even lower than original levels due to increased efficiency.
Attractiveness to Users, Operators, and Society	The system should be attractive to all parties. Users will benefit from easier payment, more equitable fare structure, and greater flexibility in inter-modal travel. Operators could benefit from streamlined fare collection, detailed ridership data, and the ability to offer incentive pricing. Society as a whole will benefit from the use of smartcards in transit subsidy programs.
Human Factors Effectiveness	Smartcards should be very effective from a human factors standpoint. From a user perspective they will be as easy or easier to use than existing fare collection systems. Users may wish to have some type of monthly statement of transit use to verify their charges. This could be provided automatically or upon request. From an operator perspective they should reduce much of the human effort that traditionally goes into fare collection and handling.
Potential for success	The potential for success of smartcards is very high. Test systems are being proposed for several transit agencies in the United States. These systems will have applications throughout the transportation industry.
Implementation Potential	Systems are currently operating in other countries. Interest is strong.

SCENARIO 6 - TRANSIT PRIORITY ON SIGNALIZED NETWORKS

Description

Signal pre-emption systems for transit vehicles have been in use for quite some time. These systems typically detect the presence of a transit vehicle approaching a signal and either extend the green phase to allow the bus to pass through or shorten the opposing green phase to minimize delay to the transit vehicle. These systems, however, typically operate only at the intersection level and do not provide coordinated operation to optimize transit vehicle travel network-wide. Furthermore, these systems often can not differentiate between a transit vehicle that is running ahead of schedule and one that is running behind. More advanced signal control systems which will provide signal coordination network-wide could be used to give priority to transit and HOV vehicles, thus optimizing the movement of people rather than vehicles. They could further be linked to transit AVL systems and provide signal pre-emption only when a vehicle is running behind schedule. One important application of this might be during route diversion scenarios in response to traffic incidents. These systems could attempt to reroute auto traffic in such a way as to minimize its impact on transit schedules, and adjust signal timings to preserve priority for transit vehicles, even along diversion routes. With proper detection equipment, this could also be applied to HOV vehicles.

Potential Benefits

Benefits would include improved transit schedule reliability and possibly improved ridership. Transit riders and HOV users would be assured that schedules would be maintained not only during normal operating conditions, but that during incidents and route diversion scenarios transit vehicles will be given priority and auto traffic will be rerouted to minimize its impact on transit service.

Potential Costs

The scenario as envisioned would be able to use in-place transit AVL systems and network-wide signal coordination systems. If implemented in a mature IVHS environment it would require only minimal additional equipment to combine the real-time vehicle location and schedule information with traffic data received from the signalized network.

Institutional/Legal Barriers

There are some potential institutional barriers to this scenario. First, it will require cooperation between transit agencies and traffic control agencies to exchange data and coordinate operation. It supposes a "unity of purpose" that may not exist between many agencies. Second, the commitment to preserve transit schedules to the extent possible during incident management and route diversion scenarios will be a policy issue that will need to be worked out between the different transportation management authorities.

Financial Feasibility

Since this system would utilize existing equipment, the additional costs for operation should be fairly low.

Attractiveness to Users. Operators, and Society

While this scenario should be attractive to transit users and transit operators because it would help to maintain schedule reliability, it may be unattractive to other roadway users and traffic managers whose interest may lie in optimizing overall traffic flow and reducing overall vehicle delay.

Human Factors Effectiveness

Ideally, the system would be almost entirely automated, requiring very little human input from traffic managers and no behavior modifications for transit vehicle drivers.

Potential for success

To be successful, this scenario will require policy commitments to transit priority strategies from the various transportation management agencies involved. In that environment, its potential for success should be high.

Implementation Potential

Many cities use signal pre-emption equipment right now. As transit AVL systems and advanced signal control systems are deployed, this could be implemented on **a** test scale.

SCENARIO 7 - TRANSIT VEHICLE INFORMATION DISPLAYS

Description

The Americans with Disabilities Act (ADA) will require that transit companies provide both audio and visual information to passengers on fixed route transit vehicles. This type of information is commonly provided on rail vehicles, but is rarely found on buses. Some basic systems which utilize dot matrix displays and automatic audio annunciators have been tested on U.S. transit vehicles, but they have largely been limited to displaying route number, destinations, and announcing major intersections. With the deployment of AVL and ATIS systems on transit, these systems will be able to convey more information to travelers in real time. The use of AVL with map matching functions will allow the system to display/announce all stops automatically (or broadcast them via short range FM), display schedule and transfer information, and display advertisements to bring in additional revenue. Additional schedule displays and annunciators could be installed at major stops and transfer points.

Potential Benefits

This type of system would make transit more “user friendly” for both handicapped and non-handicapped persons. It could provide locational, schedule, advertising, and other information to passengers while on transit vehicles.

Potential Costs

It would require buses to have some type of AVL system in place. More advanced versions would also require some type of onboard ATIS. It is reasonable to assume that AVL and ATIS systems will become fairly common on buses in the future, so only the incremental cost of installing onboard message signs and annunciators should be considered. On-board displays/annunciators currently available can run as high as $7000 per bus, but these may become less expensive as (ADA) requirements increase demand for them.

Institutional/Legal Barriers

There should be few institutional or legal barriers to this type of system, and in fact institutional requirements may soon mandate their use. The use of onboard displays to also carry advertising may not be desirable on some systems, but this is a non-essential function.

Financial Feasibility

Part of the cost of implementing these systems could be offset by the use of the displays for advertising as well as transit information. This use has met with some success in tests in Canada.

Attractiveness to Users. Operators and Society

These systems will of course provide large benefits for the hearing and visually disabled, but their perceived utility should not be limited to these groups. All users of transit will benefit from these improved information systems. Automation will ensure that accurate information is provided to the riders without forcing drivers to divert any of their attention from the road.

Human Factors Effectiveness

These systems should greatly improve the user friendliness of bus transit in particular. Will not require any training or behavior modification on the part of transit operators.

Potential for success

This should be fairly high. Similar, though more primitive, systems have been successfully tested in Europe and in the U.S. Initial reactions have generally been favorable.

Implementation Potential

This should be high as more transit agencies begin to meet ADA requirements, Many transit companies are also installing AVL and ATIS devices, which will make these information systems far more effective than current versions.

SCENARIOS-TRANSIT SCHEDULE RELIABILITY

Description

It is difficult for transit systems to maintain schedule reliability when buses must operate on congested arterials. In Los Angeles, an innovative Service Reliability Program (SRP) has been implemented using an increased number of street supervisors who have the authority to call additional buses into service when scheduled trips are delayed for any reason. This is costly due to the supervisory labor required in the field. An M-IS system would provide information to dispatchers now gathered in the field. This system would use AVL and ATMS technologies to monitor the position and status of transit vehicles on the roadway network. This would go a step beyond the AVL systems currently being implemented in that it would also utilize real time traffic data to predict potential disruptions in service and allow operators to take active measures to avoid delays to transit riders before they occur such as rerouting, signal pre-emption, or dispatching additional vehicles.

Potential Benefits

The benefits of such a system would be a reduction in delays, increased schedule reliability, and reduced crowding for transit users. Increased transit schedule reliability will also increase user confidence in the system and thus may attract some additional transit riders. The unreliability of transit in many areas is currently a major disincentive to its use.

Potential Costs

Assuming that most major transit agencies will have implemented AVL systems in the near future, the incremental cost for the monitoring functions of this type of system would be fairly low. The potentially high costs would result from having to keep several buses on stand-by during peak periods. Most transit companies have few vehicles to spare during peak hours, and, stand-by drivers would likely receive substantial pay even if no work was performed.

Institutional/Legal Barriers

Cost efficiencies in this type of system might be achieved by modifying labor agreements to permit lower pay for stand-by service or contracting with a private carrier to provide the backup service. Otherwise, there would be few institutional or legal barriers to providing this service.

Financial Feasibility

The practicality of wide-scale implementation of a system which dispatches stand-by vehicles in the event of severe congestion may be uncertain from a financial standpoint. Few transit agencies have extra vehicles and extra dollars to spare. If congestion-related delay is frequent, then the overall regular schedule will often be adjusted. If congestion-related delay is infrequent, then use of an extra bus and driver may be viewed as an unproductive use of resources.

Attractiveness to Users, Operators, and Society

Would provide a tangible benefit to transit users (i.e., more reliable service with less bunching and crowding of vehicles). Attractiveness to operators for a basic headway maintenance/congestion avoidance type system should be high with an AVL system already in place. Costs to operator and society for maintaining stand-by vehicles and drivers may be seen as unproductive and therefore unattractive.

Human Factors Effectiveness

There would be no major training required on the part of operators. There would be no behavioral changes needed on the part of users.

Potential for success

Success of a basic system which monitored vehicle progress and maintained headways would be fairly high. Success of a stand-by system could also be fairly high if implemented on a limited number of routes which suffer from serious congestion. Network-wide implementation of a stand-by system may prove impractical.

Implementation Potential

System would be relatively easy to implement if the support was there from both a funding and institutional viewpoint.

SCENARIO 9 - IMPROVED TRANSIT MANAGEMENT INFORMATION

Description

This system would collect information on vehicle condition and driver performance so that transit management could more effectively monitor the operations of their fleet. Vehicle performance data would include such items as engine temperature, oil pressure, air pressure, and other factors that might indicate a need for service. Data on an impending breakdown could be transmitted directly to the operations / maintenance center. The other type of data collected would relate to driver performance. These data would include operating speed, brake use, on time performance, etc., and would be downloaded at the end of each shift. This technology exists today, but advanced systems could automate the collection and analysis of this data in real-time. Benefits could be obtained on a fleet-wide rather than just au individual vehicle basis.

Potential Benefits

Potential benefits of a vehicle performance monitoring system would include a reduction in maintenance costs and a reduction in the number of breakdowns by allowing operators to correct problems before they become serious. It would also allow operators to dispatch a replacement vehicle at the first sign of trouble. A driver performance monitoring system could obviate the need for field inspectors to monitor vehicle on-time performance and allow operators to screen out bad drivers.

Potential Costs

The system would require an array of onboard sensors to monitor performance and store the data. The system would also require advanced software to analyze the voluminous data that would be generated.

Institutional/Legal Barriers

Vehicle drivers may object to having onboard systems which monitor their performance, and such systems may violate union agreements. There should be no barriers to vehicle performance monitoring equipment, although some may feel that it is a job that could be adequately performed by the driver.

Financial Feasibility

Benefits of such a system should outweigh the costs, particularly with respect to vehicle maintenance. Drivers currently perform many of the vehicle monitoring functions, but automated systems could monitor a wider range of functions and could add a predictive element.

Attractiveness to Users. Operators, and Society

The system would have little noticeable effect for transit users, except in cases where it resulted in markedly improved system reliability. The main attractiveness would be for system operators who could reduce maintenance costs and improve system reliability. Some drivers may object to systems that monitor their performance.

Human Factors Effectiveness

The system would require few behavioral changes on the part of users or operators. The system will require user friendly software that can analyze the data (either in real time or semi-real time) and generate appropriate summaries, identify problems, and make recommendations.

Potential for success

The potential for success is high for these types of systems. Automated monitoring of vehicle performance could reduce overall operating costs.

Implementation Potential

This should be high. Manufacturers are beginning to introduce elements of these systems into transit vehicles.

SCENARIO 10 - ACCIDENT DATA RECORDING

Description

Transit agencies are facing ever growing liability claims for injuries sustained during accidents. Fraudulent claims (e.g., 25 people filing accident claims when only 15 people were on the bus) can account for a great percentage of these costs. In order to help reduce accident claims and lower liability costs for transit operators, buses and other transit vehicles could carry accident data recorders, similar to the "black boxes" carried on commercial aircraft. These devices could record vehicle performance variables such as speed, direction of travel, and brake use, as well as passenger count data and even passenger identification if smartcards are in use.

Potential Benefits

This type of device could reduce fraudulent liability claims and provide accurate data on vehicle and driver performance at the time of accidents. The overall benefit would be reduced liability costs for transit agencies.

Potential Costs

It would require that data recording devices be installed on all vehicles. Some "smartbus" applications will record many of these data for other purposes (e.g., driver performance monitoring, passenger count monitoring, and post use-billing) and if combined with an AVL system, it may be possible to gather much of **this** data without special equipment.

Institutional/Legal Barriers

One possible barrier to the use of this system would be questions of privacy in monitoring passenger identities. It may not be possible or desirable to record passenger identities on buses. Additionally, the recording of passenger identities would only be practical if all riders used smartcards, which is not likely unless the transit system requires their use.

Financial Feasibility

If other "smartbus" features such as AVL, passenger counting equipment, and vehicle performance monitoring equipment were present, then much of the accident data might be recorded without special equipment, thus making it financially attractive. If none of this equipment were present, the cost of installing an accident data recording device could be quite high while the cost savings are at this point uncertain.

Attractiveness to Users, Operatiors, and Society

All direct benefits of this type of system would he for the operator. Operators would be reluctant to implement this type of system unless they could be assured that cost savings would exceed cost of installation.

Human Factors Effectiveness

This scenario would not require any behavior modification on the part of operators, drivers, or passengers.

Potential for success

The monitoring of vehicle and driver performance could be done fairly easily and will probably be quite common in the future. Recording passenger data will be more difficult. Obtaining passenger counts is certainly feasible but would have only marginal usefulness in combating fraudulent claims. Obtaining passenger identification information is possible with smartcards, but for the system to be completely effective it would require all passengers to use smartcards, which is unlikely. Alternate methods might be considered, such as the use of surveillance cameras onboard. This might be a good opportunity for a public-private venture between transit operators and insurance companies.

Implementation Potential

Low to moderate. Operators will have to be convinced that the system can reduce liability costs. It may require government subsidies for operational testing.

Description

While most carpool/vanpool activity is pre-arranged, real-time ad hoc ridesharing does exist today. In corridors having HOV lanes with minimum occupancy requirements, it is not unusual to see drivers of single occupant vehicles (SOV's) stopping at bus stops to seek passengers for their vehicle so that they can qualify to use the HOV lanes. IVHS technology offers the potential to expand and improve these ad hoc systems. In such a scenario, a driver seeking passengers (or vice-versa) would enter a request into the system stating his/her destination. The system would match potential drivers with potential passengers and "offer" the passenger to the nearest driver. The goal of a real-time rideshare brokerage system is to encourage the use of ridesharing by providing ridematching, "instant" carpooling, and incentives to Carpool.

Potential Benefits

There are several potential applications and benefits associated with such a system:

- Reducing SOV trips, highway congestion, and air pollution, and increasing the efficiency of HOV facilities by encouraging ridesharing.
- Providing a low-cost alternative to conventional transit in low-density rural and suburban areas. These are areas where traditional transit services are costly and often inefficient. It could be of particular use in serving the growing number of suburb-suburb commutes.
- Improving the mobility of the transportation disadvantaged, particularly the elderly and handicapped. Real-time rideshare systems could either replace or augment existing paratransit systems, improving system response and lowering operating costs.
- Providing "instant" carpooling services during air pollution alerts or other emergencies.

Potential Costs

Such a system requires a computerized brokerage center to perform the ride-matching functions. The annual cost of operating such a center has been estimated at approximately $36 per capita for a low density area, based on existing audiotex/videotext based technology. If the system is to be integrated with existing transit and paratransit systems, there may be additional costs associated with providing auxiliary services when a ridematch is not available.

User costs may include a subscription fee or a charge per use. Fees should be set to equalize supply and demand for ridesharing, and should be competitive with conventional modes.

Institutional/Legal Barriers

User safety and operator liability would be two of the major concerns in such a system. User safety could be provided in several ways. One system would require all users to be registered in the system in order to use it. A computer could then check for criminal records and driving history before assigning rides. This type of system may provide the optimum in security, but may also make it impractical for the infrequent user. Another option might be to allow the user to specify preferences for certain driver/passenger profiles or allow them to review a profile before accepting a rideshare arrangement. This type of system would, however, raise the potential for discrimination. The provision of in-vehicle security alarms combined with AVL systems in more mature versions of this scenario could add an extra measure of safety. In any case, it is felt that adequate security measures could make ridesharing even safer than conventional transit modes.

The question of liability for both drivers and operators of the system will need to be addressed. In the case of drivers, the potential liability for injuries sustained by riders in an accident could discourage system use. For operators, liability for user injury due to accident or crime could create an excessive financial and insurance burden and discourage implementation by local agencies. Local laws will need to be examined and modified if necessary to relieve some of this burden.

Financial Feasibility

Operating subsidies would probably be required to maintain user costs at an acceptable level. These subsidies could potentially be generated through road-pricing and parking fees, system advertising, or other transportation user fees. If significant reductions in congestion could be gained it would remain a lower cost alternative to roadway construction and other conventional congestion mitigation measures.

Attractiveness to Users. Operators, and society

Provided the incentive levels are high enough, it should be a fairly attractive scenario to both users and society. Drivers would earn extra money through ridesharing, while riders would benefit from better service, increased mobility, and possibly reduced transportation costs. Society would benefit from reductions in congestion, pollution, and potentially reduced transportation spending. Operators of existing transit, paratransit, and taxi services could also benefit from such a system if their services are properly integrated into its design. Rideshare vehicles could serve as feeders to transit stations, relieving the transit agency of some of the cost of providing these services. Taxis could serve as alternate vehicles for trips which can not be served by a ridematch.

Human Factors Effectiveness

The system should be fairly easy to use, probably utilizing familiar touch-tone phones during its initial stage. In-vehicle navigational aids and ATIS systems will greatly benefit this type of system by guiding drivers to pick-up points and destinations and advising them of current traffic conditions. Ideally, the rideshare center would automatically compute user fees and deduct them from pre-paid accounts so that no money would change hands and there would be no disagreements over prices.

It will be of primary importance to establish a level of user confidence in the system both in terms of reliability and safety. Information must be accurate and provided on a timely basis, and security must be comprehensive enough to attract a large user pool.

Potential for success

While this system is attractive, it will require a large enough user pool to make it effective. Higher incentives may need to be offered initially to gain this "critical mass." Incentives will need to be clearly defined and attractive enough to gain acceptance from each segment of the user population. The target groups for this scenario should be clearly defined and their needs addressed. Providers need to ensure that a person not only arrives at his/her destination on time but can also return home afterwards.

Implementation Potential

Should be fairly high. Requires a relatively low investment and may be an effective and efficient means of transportation in lower density areas. There are few major obstacles to implementation, namely safety and liability, and these can be overcome with proper system design. It should be noted, though, that current ATIS architectures do not permit the driver to input his/her origin and destination data. Future architectures may need to be modified to accommodate this.

SCENARIO 12 - PARATRANSIT DISPATCHING

Description

Paratransit, sometimes referred to as dial-a-ride, involves transit services that do not operate on a fixed route or a fixed schedule, but rather operate on routes and schedules in response to passenger service requests. While some agencies are using or are attempting to use real-time dispatching, most paratransit agencies currently require at least 24-hour advance service requests so that dispatchers can develop efficient service routings. An IVHS enhanced operation could permit real-time processing of paratransit requests through the use of AVL systems and automated computer routing. The system could receive a request, dispatch a vehicle and even select the optimum vehicle type or size, and confirm the arrangement with the passenger all in real-time. The system could further be enhanced by linking the dispatch center with a local TMC so that routing algorithms could use real-time traffic information to compute the most efficient routes, rather than basing routing simply on the shortest path. The system could be useful in both urban and rural areas.

Potential Benefits

Better and more flexible service could be provided to paratransit riders. Users would be able to make more "spur of the moment" travel plans. With computerized vehicle routing, operators would potentially be able to provide the service using fewer vehicles, driver hours, and vehicle miles. In-vehicle information and map displays would guide drivers to their pick-up points, eliminating time lost looking for the destination. The system could also permit the use of private carriers to provide the paratransit service with a central facility controlling the dispatching and routing of all of the vehicles.

Potential Costs

To be effective, the operation would require all vehicles to be equipped with some type of AVL and ATIS/route guidance systems. The dispatch center would require equipment to monitor vehicle locations and computers to automate vehicle routing.

Institutional/Legal Barriers

This type of system may compete with local taxi services since paratransit agencies would now be able to serve customers in real-time. To avoid potential conflicts with local taxi operators, paratransit operators should attempt to integrate their services into the operation, providing rides when a paratransit vehicle is not available or when a taxi would be more efficient. Obtaining cooperation from taxi services would not only enhance paratransit operations but could also avoid obstacles to government funding. For maximum effectiveness, the dispatch center would also require a link with the local TMC to exchange traffic and vehicle information.

Financial Feasibility

Overall, the system should lead to reduced operating costs. More efficient vehicle selection and routing, and increased automation will permit the use of fewer human operators and reduced vehicle miles traveled, Government funding may be an issue if the service competes with private transportation services.

Attractiveness to Users. Operators, and Society

Attractiveness to users would be high. The system would permit greater mobility for paratransit users, particularly the elderly, handicapped, and those in rural areas who have restricted access to transportation services. Attractiveness to operators should also be high as the potential exists for reduced costs and improved service. The system would also be attractive to society as it could offer improved paratransit service and facilitate the use of private companies to provide paratransit services under overall public control.

Human Factors Effectiveness	Upon boarding the vehicle, an onboard system could provide riders with printouts of their itinerary and any directions for transfers if required, thus facilitating use of the system. Human factors for users will depend on the complexity of the ride request system. The systems could use existing phone-in type request system with computer assisted dispatch. Automated phone-in requests could be handled using a touch-tone menu type system widely used to&y. Fully automated operation may require pre-registration of system users to avoid abuse of the system by non-eligible persons. This could have an added benefit of allowing pre-payment through accounts held by the system. In either case, human factors requirements would be minimal. After the user request has been entered, some type of verification of pick-up time and location should be given to the user, along with any other information pertaining to the trip (e.g., transfers or return trip information).
Potential for success	Potential for success should be very high. The system would increase efficiency of existing paratransit services.
Implementation Potential	Several paratransit, taxi, and commercial delivery services use elements of this system already. Improvements to these systems would have high implementation potential.

SCENARIO 13 - TAXI MANAGEMENT/ USER-SIDE SUBSIDY WITH SMARTCARDS

Description

User-side subsidy systems have been proposed and used in some locations as a way to involve the private sector in transit service provision (usually for the elderly and handicapped) and to include both competitiveness and consumer choice in transit operations. Factors impeding the implementation of user-side subsidy systems and causing the failure of some systems have been related to inconvenient payment methods for users, the inability of taxi management to control driver behavior, and the difficulty of monitoring use to prevent fraud (or the perception of possible fraud). The use of smartcards or magnetic stripe cards and onboard data recording devices could give system management the degree of control necessary to ensure that drivers respond to user-side subsidy user calls. The use of smartcards inserted into a unit in the taxi could provide for easy payment and automated billing and could mitigate the opportunities for fraud.

Potential Benefits

The system could allow for automated billing and enhanced fraud prevention for user-side subsidies. Onboard recording systems could register the receipt of a service call, so that management could ensure that drivers were responding to all subsidy calls. An onboard smartcard reader could record passenger information to prevent fraudulent claims and allow the taxi company to automatically bill for user-side subsidies. Ease of payment, something that has often been lacking in previous systems, could increase user acceptance of these systems.

One area of application for this scenario would be its use in guaranteed ride-home services. The lack of a means of getting home from work in an emergency or late at night is a major disincentive to carpooling. Employers could contract with local taxi companies to provide guaranteed ride home services. Employees could use a company issued card to pay for the service when used, and employers could get a written record of charges to ensure that the system is not being abused.

Potential Costs

The system would require taxis to have onboard smartcard readers and onboard information recording equipment. These systems, similar to those that will be used on transit vehicles, may become standard equipment on taxis in the future, just as in-vehicle information terminals are becoming more common in taxi fleets today. Overall implementation and operating costs should be moderate.

Institutional/Legal Barriers

Implementation and operation of such a system will require the cooperation of both the public and private sectors, but not to a significantly greater degree than has been required by previous user-side subsidy systems. Providers may request some public subsidies in order to institute this type of system. The question of privacy could be raised as some users may object to a system that records passenger names and trip information. These are not, however, seen as major barriers to implementation.

Financial Feasibility

Automated billing and fraud reduction could easily yield benefits exceeding costs. Providers of user-side subsidy taxi service have often required guaranteed revenues before offering certain services. Such may be the case here. Providers may require guaranteed revenues, at least for a while, to cover the cost of implementing this system.

Attractiveness to Users, Operators, and Society

For users of the system it would permit simplified payment and thus greater ease of use. It permits targeting transit subsidies to the intended users (e.g., the elderly and disabled). Automated billing is beneficial to all parties and fraud prevention will help reduce costs to the local transit agencies. Some taxi operators, particularly small companies, may resist implementation on grounds of cost.

Human Factors Effectiveness

Ease of payment has been cited as one of the major factors determining user acceptance of user-side subsidy transit systems. Smartcards would greatly simplify payment and collection with no complicated training required of users or operators.

Potential for success

The need for more flexible payment methods, automated billing, and fraud control have been clearly demonstrated in previous test projects. Use of MIS technologies will make user-side subsidy systems more practical for widespread implementation. Its use in guaranteed ride home services could be particularly effective.

Implementation Potential

There is a need to demonstrate the successful use of market-oriented approaches to providing transit. Implementation of this type of system would address many of the shortcomings of previous attempts at providing user-side subsidy service. This could be a useful demonstration project for Federal or local transportation agencies. The scenario could prove useful in both urban and rural areas.

SCENARIO 14 - URBAN GOODS AND PASSENGER MOVEMENT

Description

Courier and delivery companies currently operate large commercial fleets in urban and suburban high activity centers. These areas frequently experience heavy congestion. As a means of reducing congestion and improving the utilization of delivery fleets, the movement of people and goods could be combined in high activity centers as follows. A fleet managed to move goods through a courier service could be modified to provide for the simultaneous movement of people. Couriers could provide the service to businesses for free or for a nominal fee provided that they agree to use the provider for their courier service. To use it, passengers could call a dispatch center for a ride. AVL would keep track of all delivery vehicles and real-time vehicle routing software would dispatch an appropriate vehicle based on proximity and delivery schedule. This type of service could be a low-cost alternative to conventional paratransit and transit.

Potential Benefits

The benefits of this type of service would be numerous. First, it would increase mobility in high activity and suburban centers while reducing vehicle-miles traveled (VMT) and congestion. It would make more efficient use of courier vehicles already in service (it is estimated that in Washington, DC, for example, 250 courier companies generate nearly 750,000 vehicle-miles of travel every day). Reduced congestion would also bring benefits of reduced energy consumption and pollution emissions. Such a system could be used as a marketing tool by courier companies and could lead to increased revenues.

Potential Costs

Delivery vehicles would have to be modified to carry passengers and would have to meet safety standards. Operators would also have to obtain licenses to carry passengers and would face increased liability costs. It is not clear whether operators would have to meet handicapped access requirements. There is also the potential for competition with and adverse impacts on existing transit services in the area.

Institutional/Legal Barriers

Courier services would have to be licensed to carry passengers and their vehicles would have to meet safety standards. This type of service would almost certainly require some modifications to existing laws to allow courier vehicles to carry passengers, as some areas prohibit commercial vehicles from carrying passengers. This scenario might also meet resistance from local taxi providers who may see this as an infringement on their territory. In fact this type of service would not be expected to have a major impact on taxi service. Courier/passenger service will most likely attract people who would have otherwise driven their cars to some destination within the activity center (e.g., running an errand or going to lunch) and not the traditional taxi user. Nonetheless, opposition from taxi providers could be one barrier encountered by this service.

Financial Feasibility

The financial feasibility of this system will have to be determined through operational tests. The main benefit for the courier company will lie in its ability to attract new customers by offering this service. It will have to be determined how many customers will find this service attractive enough to sign up. It would be possible for a fairly large courier company to provide this type of service with a relatively small increase in operating costs. Provision of this service, however, would most likely have to be limited to high density areas, as service in low density areas might prove impractical. Funding for an operational test would most likely have to come from the private sector, as government funds could not be used if the test would give one courier company a business advantage over another. Cooperation with a local TMA would be vital in initiating this type of system.

Attractiveness to Users, Operators, and Society

The system would be attractive to users, operators, and society. For users, it would offer increased mobility in high activity centers at minimal or no cost. For operators, it could be used to attract new customers and make more efficient use of vehicles already in service. For society as a whole, widespread use of this type of service could reduce congestion, emissions, and energy consumption in high activity centers.

Human Factors Effectiveness

To make the system easier to use for both passengers and operators, a system of designated "stops" could be used. Passengers would make ride requests via telephone by using preset codes for their origin and destination and would be given time and place for pick-up. Vehicle routing and dispatching could be automated assuming that the courier vehicles were equipped with AVL systems and information displays.

Potential for success

The potential for success must be considered moderate at this point. This type of scenario has gamed interest from some courier companies that are examining ways to better utilize their fleets, but it is unknown at this point just how many users this type of system could attract or how profitable it could be. The system would need to gain a large enough user population to offset the costs that would be associated with implementation. Operational testing will be required to determine the true feasibility of this scenario.

Implementation Potential

Operational testing will require a strong commitment from one or more courier companies. At this point there is one courier service in the Tyson's Comer, VA area that is interested in testing this service. Since the initiative and funding will have to come largely from the private sector, implementation will require close cooperation between the courier service and local transportation management agencies.

SCENARIO 15 - RURAL ATIS/ROUTE GUIDANCE SYSTEM

Description

Rural paratransit services often must operate in environments where road marking is either poor or non-existent, houses are sometimes unmarked, and drivers are often part-time volunteers who may not be familiar with some of the areas. In addition, it may not be practical to implement comprehensive M-IS/route guidance systems in many rural environments. What may prove most useful is a self-contained in-vehicle ATIS/route guidance unit which could guide drivers to pick-up points and which would be portable so that it could be transferred between vehicles, thus allowing volunteer ride providers to use the unit without requiring one for each vehicle. This type of unit would require a GIS type data base with all of the information for a service area contained within and software that could translate this data into audio/video instructions for the driver.

Potential Benefits

The ATIS unit would guide drivers to pick-up points, thus reducing difficulties and delays in providing service, and would also allow for real-time dispatching of vehicles. Portable units would reduce costs and allow devices to be shared between several volunteer vehicles.

Potential Costs

This scenario would require the purchase of in-vehicle guidance units. Would also require a GIS type data base which would contain the locations not only of streets but of individual residences as well. While detailed network data bases exist or are being created for many urban areas, it is likely that many rural areas will not be covered and data bases will therefore have to be "custom made." This could represent a significant cost.

Institutional/Legal Barriers

There would be no major institutional barriers to the use of this type of system.

Financial Feasibility

These units would supplement existing services. Because many rural paratransit agencies operate with limited funds, the ability to transfer units between vehicles will be important as a cost saving feature.

Attractiveness to Users. Operators, and Society

This would be very attractive to rural transit and paratransit operators. It would allow them to serve in unfamiliar areas and possibly reduce costs through fewer miles traveled.

Human Factors Effectiveness

Maps and guidance instructions will need to be clear, especially in poorly marked areas. Since it may not suffice to simply provide route names, the system may need to provide landmarks, descriptions of pick-up points, and topography. These features become very important in very low-density rural areas.

Potential for success

Should be fairly high. Lack of adequate route guidance is a problem for many rural paratransit agencies.

Implementation Potential

May require some government funding for operational testing and implementation. Development of custom data bases may prove too costly for rural agencies to bear alone.

SCENARIO 16 - REAL-TIME TRANSPORTATION INFORMATION AT HOMES, WORKPLACES, AND STORES

Description

Transportation information units would be available at homes, shopping areas, office buildings, and manufacturing facilities. All units would receive real-time data **on** traffic and transit via cable TV or videotext systems. Persons who have completed shopping or are leaving work could obtain from these units information concerning travel to their destination. Indications of congestion **or** behind schedule bus operation would permit the individual to decide whether to travel as planned, alter his/her route, or perhaps work later or continue shopping. Similarly, persons making trips from home could check traffic and transit information before leaving and adjust their plans accordingly.

Potential Benefits

By providing real-time transportation information to travelers at home and at major activity centers before they undertake their journey, the potential benefits include:

- Avoidance of unnecessary delays, costs, aggravation, etc. by knowing in advance what modes and routes are experiencing problems/delays.
- Reduced traffic build-up at incidents, thereby allowing traffic flow to recover more quickly once the incident has been cleared.
- Improved detouring alternatives for drivers.
- Improved energy efficiency and reduced emissions as a result of congestion avoidance.

Potential Costs

Costs would include the installation of information terminals in activity centers. These could be required in new buildings as part of transportation management plans and could have subsidized installation in other centers. Information could be provided to homes via cable TV and some of the cost could be defrayed through user fees, This would of course require the cooperation of the cable company. It is assumed that all travel information would come from existing ATMS.

Institutional/Legal Barriers

At this time, it is unclear whether these systems would operate under public or private control, and it may well vary from place to place. Under privatized scenarios, geographic areas might be divided up and allocated to individual companies (not necessarily along political boundaries) as cable franchises are done today. It would therefore require agreements between jurisdictions to allow the companies to gather and disseminate information in all areas. Under either public or private control, there will need to be coordination between regional and local ATMS systems to provide the necessary information. If these systems were to also provide recommendations for detours around congested areas, control may be better placed under these ATMS centers. The system would also require cooperation from local cable TV operators to broadcast the information to homes.

Financial Feasibility

Since this type of system would most likely receive its travel information from local and regional ATMS and transit control centers, the major costs would lie in the dissemination of that information. Financing could come from fees charged to the end user, fees paid by the host facilities, public subsidies, or some combination of these. It is uncertain whether or not private operation would be profitable.

Attractiveness to Users, Operators, and Society	Such a system would be particularly attractive to users in areas that experience heavy congestion by providing them with information they need before beginning their trip. User attractiveness may be less so in areas where congestion is less severe, but the service would still be useful. Its attractiveness to transportation managers should be high if it permits reductions in congestion and better utilization of transportation facilities. Attractiveness would also depend on whether the system was being run as a public or private venture. Private ventures would require sufficient sustainable demand and/or subsidies to ensure profitability. For society as a whole, such a system would be attractive because of its numerous potential benefits.
Human Factors Effectiveness	From the user's perspective, the systems user friendliness can not be stressed enough. Success of this scenario is highly dependent on the information outlets being easy to find and use. They should provide information in a format that is easy to understand, even for novice users. As with any ATIS system, credibility will be essential for success. Many travel information systems in use to&y lack user confidence because of inaccurate or untimely information. It will be crucial that the information provided is timely and accurate, or users will lose confidence in the information provided.
Potential for success	Such a scenario appears to be very attractive for society as a whole and to a wide segment of the user population. The potential for success in an operational sense should be high. Whether or not these systems can be "commercially" successful will have to be determined by market research and operational testing. This scenario's maximum potential will be realized with its full integration into regional ATMS/ATIS systems.
Implementation Potential	Some limited scope prototype systems of this type are in operation or are being planned in several urban areas. There appears to be strong interest in these types of systems.

SCENARIO 17 - NEEDS SCHEDULING

Description

Traditional ATMS/ATIS concepts have focused on providing the user with the most efficient means of traveling from point A to point B. While these systems may provide alternative routing plans and even encourage use of alternate modes, they do not directly affect overall travel demand. The needs scheduling system envisioned here would be able to reduce travel demand in certain areas during periods of severe congestion by diverting travelers away from point B to an alternate point C where there needs could be served equally well or better. Furthermore, the system could recommend transit and other alternative modes of getting to their destination, thus reducing SOV travel. The system could also eliminate some travel demand by allowing people to “shop at home” through interactive catalogue shopping. As described, users would enter their needs via computer, videotext, or an interactive television type input. The system would determine which stores have the products desired and which are the most convenient given location, travel costs, and current traffic conditions. The system could direct users away from congested areas or even present them with mail order or shop-at-home alternatives.

Potential Benefits

The potential benefits of such a system would include reductions in congestion and delays in the vicinity of shopping centers and other high activity centers, and potential reductions in vehicle-miles traveled (VMT) through more efficient routing and shop at home services.

Potential Costs

The system would require linking traffic informationnetworks with commercial inventory systems at stores. The information could be transmitted to homes, shopping centers, and businesses via either videotext or interactive cable TV systems. Users would probably need to be charged some subscription fee to cover the cost of service.

Institutional/Legal Barriers

To be successful, this system would require the cooperation of major retail centers, and therein may lie a problem. While some retailers may view such a system as a benefit and a form of “advertising”, others may not like the idea of having customers diverted away to other sites for any reason, even if they do not have the specific item in stock or are experiencing severe congestion. Such a system could be seen to “favor” shopping centers in less congested, lower density areas if it is not run properly. It could also raise questions of what exactly is considered “congestion.” These questions could become even more important if the system is privately operated. While these are legitimate concerns, the potential benefits to consumers could be quite high and therefore ways around these problems should be examined.

Financial Feasibility

This type of system could be operated either publicly or privately. One possible outlet would be to offer it as part of computer network subscription services such as CompuServe or Prodigy, similar to some basic shop-at-home services that operate now. Information terminals could also be provided in shopping centers with the cost paid for by the host. Alternatively, it could be offered through interactive cable TV services for which a user fee could also be charged.

Attractiveness to Users. Operators, and Society

The system should be very attractive to users provided the service is accurate and reliable and available at a reasonable cost. The system’s attractiveness to retail operators may be questionable in areas where recurring congestion might lead to frequent diversions away from those stores. For society as a whole, such a system could lead to reduced congestion and VMT in areas around shopping centers.

Human Factors Effectiveness

It would be vital that the information provided be accurate and up to date. Customers who travel to a store only to find the desired products not there will quickly lose confidence in the system. Information terminals must be easily accessible and easy to use, and the system should provide detailed directions and route guidance to reach recommended shopping centers, as well as information on the availability of alternate modes.

Potential for success

This type of system would be most useful in areas that have significant congestion and a sufficient number of alternate shopping areas to permit diversions. It may therefore have its greatest applicability in high and medium density areas. Areas that do not experience frequent congestion may find the service (or at least the traffic information portion of it) unnecessary.

Implementation Potential

Some types of shop-at-home services are currently available through subscription computer networks. This scenario may have its greatest potential for implementation under private operation. Initially, it may be easiest to implement in areas that already have subscription computer network services.

SCENARIO 18 - AIR QUALITY ALERT

Description

The Clean Air Act Amendments (CAAA) '90 sets out congressional mandates for addressing air quality problems in non-attainment areas. Meeting the photochemical oxidant problem through reductions in mobile source pollution and VMT reduction represents a formidable challenge in many regions. The implementation of ATMS and ATIS systems could give transportation managers capabilities for real-time transportation demand management that far exceed those of current systems. During air quality alerts, transportation managers could implement automatic tolls and road pricing policies to discourage SOV trips and encourage HOV use. Information could be made available to travelers about highway restrictions and the availability of alternate modes of transportation (see "Multimodal Trip Planning" scenario). Some centers could coordinate real-time ridematching for carpooling. All the while, real-time traffic information collected by traffic management systems would be fed back to the monitoring center for evaluation of the effectiveness of the mitigation measures. Management policies could be adjusted in real time to meet attainment levels and the related VMT data could be recorded to verify this. ATMS would also prove useful in adjusting signal timings and traffic control devices to accommodate new travel patterns. This scenario could be applied equally well to weather alerts (particularly snow and ice conditions) and special events.

Potential Benefits

This scenario would permit urban transportation managers to implement and monitor the effectiveness of pollution mitigation measures. IVHS systems could provide a wider range of mitigation measures and allow these to be modified in real time to meet attainment goals. It could also measure reductions in SOV trips and VMT to confirm that attainment goals are being met.

Potential Costs

As envisioned, this system could utilize systems in place for ATMS and ATIS to gather and disseminate most of its information. It would require little additional infrastructure if traffic monitoring and traveler information services were already in use. It would most likely require an air quality monitoring and control center to coordinate mitigation measures.

Institutional/Legal Barriers

For this scenario to be effective, it will require a regional authority to supervise the implementation of pollution control measures. This authority will have to have the participation of all jurisdictions involved so that mitigation efforts could be coordinated for maximum effectiveness.

Financial Feasibility

If it is able to utilize existing IVHS facilities, this scenario could be operated at a moderate cost by a regional air quality authority with potentially substantial benefits.

Attractiveness to Users. Operators, and Society

The system of road pricing, restrictions, and encouraging the use of alternate modes of transportation may be seen as an inconvenience by many users. However, given that these measures are necessary, the provision of multimodal travel information to alert travelers to restrictions and tolls and to aid travelers in choosing new modes of travel should be attractive. Both system operators and society as a whole should find this scenario attractive, as it will aid in meeting air quality attainment goals.

Human Factors Effectiveness

As with other traveler information systems, the information provided will have to be easily accessible, timely, accurate, and credible. It would be desirable to have some type of automatic notification system so that travelers are given notice of the alert and travel restrictions well before they begin to make their journey. This could be done through television and radio notification, messages broadcast for in-vehicle ATIS systems, and even some type of automatic "beeper" function on computer and videotext units that would notify the user of travel alerts even if they do not use the system directly.

Potential for success

This type of system would be one element in an overall air quality management plan. It should be an effective means of reducing mobile source emissions during air quality alerts.

Implementation Potential

Many urban areas are under Federal mandate to meet air quality attainment goals. Interest in this type of system should be high.

SCENARIO 19 - AUTOMATIC WEATHER/ROAD CONDITION MONITORING

Description	Roadway and weather conditions are a contributing factor in a significant percentage of accidents in both urban and rural areas. Monitoring roadway conditions, particularly in rural areas can be difficult, especially with conditions such as ice, fog, or dust storms which can arise very quickly. An automated system could be developed which uses both fixed sensors and vehicle probes to monitor roadway condition and visibility and transmit this information to motorists via in-vehicle ATIS, changeable message signs, and HAR. Limited and largely manual systems do exist in some mountain areas and in other areas with highly variable weather conditions and utilize primarily highway advisory radio and changeable message signs to convey roadway conditions. The system envisioned here would be automated, would have far more extensive coverage, and would utilize in-vehicle ATIS in addition to HAR and CMS to convey information.
Potential Benefits	The main benefit of this type of system would be improved safety and fewer accidents and injuries due to poor driving conditions. The system would monitor factors such as poor visibility due to fog or dust storms, rain, snow, ice, and poor traction conditions and relay that information to other drivers. The monitoring system could be integrated into urban and rural ATIS systems.
Potential Costs	Costs for this type of system would depend on the types of sensors used. Fixed sensors located at intervals along a roadway could provide constant information on roadway conditions, but installation and maintenance costs could be high. Alternatively, vehicles equipped with sensors could monitor driving conditions and either relay data back to a control center or "dump" it to electronic mailboxes spaced periodically along the route. Other vehicles could then read the data as they passed by. This type of system would require far less infrastructure and could therefore be cheaper to install. It is not known what percentage of vehicles would have these sensors, but they could be installed on police and maintenance vehicles and possibly on commercial trucks. Any vehicle with an ATIS system could receive the data.
Institutional/Legal Barriers	There will need to be nationwide communication standards for these types of systems so that all ATIS systems may receive roadway condition information. Legal issues (i.e., liability should the system fail) would be the same as those faced by current systems.
Financial Feasibility	If the system implemented is able to maximize its use of existing IVHS systems (both in-vehicle and fixed) then this could be a very cost-effective means of providing extensive coverage for monitoring weather and roadway conditions.
Attractiveness to Users, Operators, and Society	The system would be attractive to highway users in both urban and rural environments. It should also be attractive to operators as a way of automating monitoring functions and reducing infrastructure requirements.
Human Factors Effectiveness	Could reduce requirements for human operators in monitoring and control functions. In-vehicle warnings could be either audio or video and could provide more detailed information than conventional changeable message signs.
Potential for success	This should be fairly high. Many of these types of systems are in operation in areas that experience extremes in weather.
Implementation Potential	This should be high, especially in areas that experience extremes in weather or sudden changes in driving conditions such as fog or dust storms.

Description

Studies have estimated that in some urban areas 20 percent or more of the traffic during peak times is people looking for parking spaces. This is a problem that affects not only passenger cars, but also has a great impact on commercial vehicles. Delivery vehicles are often forced to block traffic because there are no loading areas available in urban areas. An ATIS system which could guide a person not only to their destination but also to a parking space would greatly improve travel in congested areas. The system envisioned would monitor the availability of parking spaces at lots, garages, and selected onstreet areas, and continually broadcast updated information to in-vehicle ATIS systems. Similar systems could monitor the availability of loading zones for commercial vehicles. If a space was unavailable, the system could advise the delivery vehicle to wait in a specified area until a space becomes available, or direct it on to the next destination for which a space is available.

Potential Benefits

This scenario has the potential to reduce needless additional travel by motorists when searching for available parking -- saving time, fuel, and frustration -- and could be particularly useful during periods of high demand such as sporting and special events and busy shopping seasons. Additionally, the real demand for parking can be tracked according to time period. For commercial vehicles, information on the availability of loading zones could lead to more efficient routing and less wasted time. This service could also be used in major suburban workplaces, shopping centers, and transportation centers. As an enhancement to this scenario, participating parking facilities could provide additional guidance to empty spaces within the lots.

Potential Costs

The costs of such a system would not be especially severe, particularly when this capability is "piggybacked" onto an existing ATIS system. Parking lots and garages would probably be more than happy to provide the necessary information to TMC's since this could be a form of real-time advertising. Parking facilities could subsidize. part of the service, with some of the cost passed on to users. The price competitive nature of this information system may actually produce some price competition among parking facilities. The monitoring of loading zones and onstreet parking through automated sensors could prove to be far more complicated and expensive and would probably only be practical in high activity centers. The question of who would pay for these systems would have to be examined.

Institutional/Legal Barriers

The issue of who manages/controls this service could be important to its operation. If public agencies coordinate operation, there is the question of who will provide funding, particularly for monitoring spaces for commercial vehicles. If operation is private, there would be the potential for "favoring" one lot or commercial carrier over another. Overall, though, institutional and legal barriers do not appear to pose a significant problem.

Financial Feasibility

If integrated into an existing ATIS system, the marginal benefits should outweigh the marginal costs, particularly for systems that primarily monitor parking lots and structures. Providing coverage of onstreet parking and vehicle loading zones may prove more costly and therefore may only be financially feasible in areas where parking problems and congestion are severe enough to warrant the costs. Financing in these areas might come from commercial vehicle operators or major generators of parking demand.

Attractiveness to Users. Operators, and Society

Within the context of a comprehensive ATIS system, this scenario should be very attractive to all parties involved. The convenience of motorists would be enhanced. Providers of parking would be able to increase motorists* awareness of their facilities, and the system would make it easier to use those facilities. For society, the impact of such a system may not be dramatic, but the system could lead to advantages such as improved area-wide parking management during special events, more accurate and efficient tracking of parking demand, and more accurately determining the need and location for additional parking facilities.

Human Factors Effectiveness

As with any information displayed on in-vehicle ATIS devices, it must be in a concise, uncomplicated, and readily understandable form for the end-user. Any graphic displays should be accompanied by text and speech instructions as well. Of course, since this system will most likely be a component of a larger ATIS system, it should be evaluated in that more comprehensive context.

Potential for success

As part of a comprehensive ATIS system this scenario has good potential for success. In the proper environment, the overall demand for such services should be high and would probably have favorable levels of satisfaction from both motorists and providers.

Implementation Potential

Some of the early ATIS studies (e.g. TravTek) have looked at these types of systems and found them to be too complex for the initial ATIS operational tests. As ATIS systems move out of the testing stage and into operation, however, these systems will likely become more and more attractive. Implementation potential in urban areas with operational ATIS should be quite high.

SCENARIO 21- PORTABLE ATIS SYSTEM

Description

The device described would essentially be a portable ATIS unit, although with more limited functions than a full size in-vehicle unit. The unit envisaged would be about the size of a pocket or palmtop computer, would be carried by the user, would have a display and memory similar to small computers, but would also have the capability to receive and possibly send information via radio. The unit would have street and transit networks for a given area stored on a CD or a storage card. The user would be able to use the unit to plan multimodal trips using either roadways or transit, obtain "yellow pages" information on stores, restaurants, banks, etc., and obtain information on local sites. Software that can perform these functions is already available in the United States for a limited number of areas. More advanced units would provide not only this static information but would also have the ability to receive real-time traffic and transit data. Such a unit could not only provide route guidance, but also real time information on traffic conditions, transit vehicle status, connections, and the location of transit stops. A built-in location unit that used either GPS or FM location technology could provide directions to stops, transit centers, and destinations while in transit.

Potential Benefits

This type of unit may be useful in several areas. First, as a portable ATIS system, it could be used to receive real-time traffic information and route guidance in vehicles that are not equipped with a more sophisticated permanent unit. It could serve as a transitional device as ATIS systems are phased into vehicles. The portable "Trafficmaster" ATIS unit has proved popular in England because it can be transferred between vehicles. Second, this type of unit could be useful for travelers and tourists in unfamiliar areas, particularly for transit use. These are typically groups that are reluctant to use transit in unfamiliar locations, and it could be a useful incentive. People could conceivably rent these units when visiting an unfamiliar area.

Potential Costs

This unit would be designed to operate within existing regional ATIS systems. Individual units would have to be purchased by the user. Units could also be purchased by businesses for employee travel use or rented to users by tourist or travel agencies.

Institutional/Legal Barriers

Like any ATIS system, the ability to use this unit in different areas will rely on standardization of equipment and communications protocols. This is somewhat uncertain at this point. It would also require that real-time transit data be broadcast in some form that could be received by the unit. This type of unit could be seen as taking business away from the taxi industry if it encourages people who would not normally take transit to do so. This is not seen as a major factor in implementation.

Financial Feasibility

Cost of individual units would have to be reasonable enough to make them attractive. Since this unit would work within existing ATIS systems, there would be no additional cost for implementation or operation.

Attractiveness to Users. Operators, and Society

The system would be attractive to users and operators of the transportation system. Users could obtain real-time traffic and transit data at just about any location. It could encourage use of transit, particularly among occasional riders, and could serve as a useful transitional tool during the implementation of ATIS systems.

Human Factors Effectiveness

The human factors related to this type of system will be similar to those of other ATIS systems. Maps must be easy to read and information simple enough to read while driving in a car. A system which provides static travel information and route displays is available today for use on laptop and palmtop computers. It uses menu driven sofhvare to display maps, travel directions, and "yellow pages" information. Transit and roadway network files will most likely have to be updated periodically. Upgrades could be made available to users at discount rates, similar to how it is currently done in the computer software industry.

Potential for success

This should be fairly high given that an ATIS infrastructure is already in place. Portable ATIS could serve a variety of functions.

Implementation Potential

These ATIS systems would not require any additional infrastructure or implementation costs.

SCENARIO 22 - TRAFFIC MANAGEMENT AT PARKS/MONUMENTS

Description

Many parks and monuments experience serious congestion during peak visiting times. This can occur in both urban and rural environments. An example of congestion in an urban environment would be the Mall in Washington, DC. Tour buses from out of town frequently clog downtown streets due to a lack of parking, and drivers unfamiliar with the area frequently get lost. Yellowstone National Park is an example of a rural park where congestion is also a great problem. During peak visiting seasons, motor vehicles create serious congestion in the park and can spoil the natural vistas which are the park's attractions. IVHS could be useful in dealing with this type of recurring but preventable congestion. In urban environments, in-vehicle route guidance could be used to guide drivers to their destinations. A system of remote parking lots would allow buses to drop off passengers and then continue on out of the area. Buses could then be paged from the lots via in-vehicle ATIS or changeable message signs. In rural areas, changeable message signs could be used to provide notice to park users well in advance (even at airports, for example) that park conditions are congested and direct them to external parking **lots.** Shuttle buses could then be used to carry visitors in between the park and the **lots.** What makes this scenario particularly interesting is that the National Park Service has expressed interest in implementing traffic management systems in parks. An operational test would allow IVHS to be tried in heavily used yet highly controlled environments with much of the funding provided by the Government.

Potential Benefits

The benefits of these systems would be a reduction of traffic congestion in the parks and the surrounding areas. The park environment could be improved and traffic managed in real-time. This would obviously use many elements of conventional ATIS.

Potential Costs

The system would require in-vehicle ATIS units on all buses and tour vehicles. It would also require a control center of some type to coordinate the movements of tour buses, transit vehicles, and the operation of the information systems.

Institutional/Legal Barriers

Since these systems would be dealing largely with out of town vehicles, it is assumed that there will be a standardization of ATIS communication technologies nationwide. To be fully effective, this scenario would require enforcement to ensure that all vehicles follow the regulations. While this may be fairly easy in rural park environments where access is controlled, enforcement in urban settings will be more difficult and will require the cooperation of the local police.

Financial Feasibility

The system could work within regional ATIS systems. Some parks are implementing traffic management systems already as congestion becomes more severe.

Attractiveness to Users. Operators, and Society

The system would be attractive to park users if it helps to relieve congestion and improve the park experience. It would provide operators with an effective means of real-time traffic management. It would also be beneficial to non-users of the parks by relieving congestion in the surrounding areas, particularly in urban settings.

Human Factors Effectiveness

The system would raise the same human factors concerns associated with other types of ATIS systems, namely, what types of information should be presented to users and in what form. Because systems should operate within the local ATIS, it should not be any more difficult to use.

Potential for success

This should be fairly high. Systems would be deployed only in those areas where needed and could be financed through park funds.

Implementation Potential

This should be fairly high. Many parks are facing increasing congestion problems and have expressed an interest in implementing traffic management systems. Traffic Management could provide useful operational test data in controlled environments.

SCENARIO 23 - AIRPORT ACCESS/PASSENGER PICK-UP

Description

Many airports in the United States currently experience severe traffic congestion problems during peak periods. Visitor traffic usually accounts for about l/3 of all airport traffic, but drop-off and pick-up areas are often inadequate to accommodate all of the demand generated. Congestion can become particularly acute when air traffic experiences major delays and people waiting to pick-up passengers begin to stack up at the airport. In general, there is a lack of intermodal coordination. Several types of IVHS systems could help to remedy this problem. First, airport flight information could be made available in homes and workplaces via cable TV and videotext systems (as it already is in a few locations). People picking up passengers could then check on flight status before leaving home and adjust their trip time accordingly. Upon arrival at the airport, visitors could again check on flight status either via in-vehicle ATIS or changeable message signs. People whose flights have not arrived could be directed to holding lots. When flights arrive, people could be directed to the pick-up point via ATIS or message signs.

Potential Benefits

This type of system could provide airports with effective curbside traffic management. It would offer true coordination between the air and highway modes and help to relieve part of the growing congestion problems that many airports experience.

Potential Costs

The incremental cost of installing this type of system could be fairly low since it could build on existing information systems. Almost all airports currently have real-time flight status displays. In addition to being displayed in the airport, they could be easily broadcast over cable TV and videotext networks at very little cost. Similarly, airport ATIS systems could transmit this data to m-vehicle and message sign displays. This system would require some type of control and transmission center.

Institutional/Legal Barriers

Provision of flight information via in-home television will require the cooperation of local cable companies. For maximum effectiveness, airport control systems should be integrated into regional ATMS. This will require cooperation with local transportation management authorities.

Financial Feasibility

The costs of operating such a system should be fairly low. The heart of the system (airline information systems) is already in use at most airports, and the incremental cost for installation should be moderate. Benefits of such a system should justify the costs.

Attractiveness to Users. Operators, and Society

The system would be attractive to both users and operators. For users it could mean reduced delays and less time spent waiting for flights. For operators it could be an effective means of alleviating some of the congestion around the airport terminals.

Human Factors Effectiveness

The system should be fairly easy to use. Information displays on flight status could be similar to those currently in use in airports.

Potential for success

Potential for success should be fairly high. System could be integrated into other highway traffic management systems.

Implementation Potential

Implementation potential should be fairly high, but may be most effective in areas where there are existing ATMS systems and a large market penetration of ATIS systems.

SCENARIO 24 - TRUCK ACCESS TO PORTS/RAIL FACILITIES

Description	Studies of landside transportation at intermodal port and rail facilities have highlighted some of the problems often associated with these operations. Among problems frequently cited were highway and street congestion in the area of port or rail facilities, lack of adequate signing to guide truckers to their destination, and physical obstacles to large trucks such as substaudard geometrics. The use of advanced IVHS technologies could help to alleviate many of these problems. The system envisioned would combine elements of AVL, AVI, GIS, and ATIS systems to provide truckers with dynamic route guidance, real-time information on traffic conditions, and special route guidance according to the type of cargo being hauled (e.g., hazardous materials) or geometric requirements (oversized or heavy loads). A port control center would exchange traffic data with the local transportation management center and then relay that data to truckers via changeable message signs and m-vehicle displays. Trucks with special requirements could transmit their needs via ATIS or have them detected automatically through an AVI system. The control center could then use a GIS based routing system to give the vehicle the optimum route based on traffic, geometrics, cargo, road conditions, population, etc.
Potential Benefits	The use of these types of control centers at major port and rail facilities could help to reduce congestion and delays for trucks, improve route guidance, and allow for dynamic routing of special cargoes. It could also improve traffic flow and safety in the areas surrounding these facilities.
Potential Costs	Assuming that a local TMC is already in operation, the incremental cost of installing a port control center could be moderate. The system would require a control center which was electronically linked to the local TMC, some AVI detector equipment, and a network of changeable message signs and ATIS communication links.
Institutional/Legal Barriers	There would be few institutional or legal barriers to such a system. This system will require cooperation with local transportation control centers so that traffic information could be exchanged and control measures could be coordinated.
Financial Feasibility	This type of system would have a moderate operating cost and could probably be funded through port usage charges.
Attractiveness to Users. Oeerators, and Society	The system would be attractive to users, operators, and society. Truck drivers would benefit from reduced delays, improved guidance, and increased efficiency. Operators would be able to mitigate congestion in the areas surrounding the facility and route vehicles around congestion should it occur. The transfer of goods between modes could be made more efficient.
Human Factors Effectiveness	The method for determining a driver's destination should be fairly simple. AVI and electronic ticketing tags could carry all pertinent vehicle information including destination, weight, size, and any special requirements. Vehicle tags could be automatically scanned and optimum vehicle routing could then be automatically transmitted to each truck through an onboard ATIS system.

Potential for success

This system would operate much like ATMS and CVO systems that are being tested in parts of the country. It could be made compatible with equipment used in other CVO systems and much of its function could therefore be automatic. If integrated with other ATMS and CVO systems it could be quite effective.

Implementation Potential

Implementation of a basic system could be done using existing technologies. Implementation of a fully mature system would probably require the establishment of transportation management centers in the surrounding areas.

SCENARIO 25 - IMPROVED VEHICLE PROCESSING AT PORT/RAIL FACILITIES

Description

Many ports and rail facilities experience excessive delays while processing incoming vehicles. These delays can be costly to truckers and can cause congestion which spills over into adjacent streets. In addition, most ports have no way to monitor the movement of vehicles once they enter the facility. The use of automatic vehicle identification (AVI), weigh-in-motion (WIM) and ATIS technologies would allow ports to process properly equipped vehicles automatically, thus greatly reducing delays. Once processed, the system could automatically guide vehicles to their loading/unloading point and monitor their movements through the port facility either through AVL or AVI transponders. During periods of heavy congestion, trucks could be directed to holding lots within the facility and called (via in-vehicle ATIS, radio, or changeable message signs) when they are needed. In a fully developed system, the control center would automatically schedule the arrival of trucks at the facility in order to reduce congestion.

Potential Benefits

The major benefits of such a system would be reduced congestion and delays at processing centers, more efficient vehicle processing, and improved monitoring of vehicle and cargo movements within the facility.

Potential Costs

The system would require WIM, AVI, and possibly AVL equipment and a control center to monitor the movement of vehicles. Trucks would have to have some type of AVI tags in order to take advantage of the automated processing. Since AVI systems are already being tested, it is expected that most trucks will have these tags in the future. And since most facilities already require weighing and processing equipment, these systems could be implemented as part of upgrades rather than as wholly new systems.

Institutional/Legal Barriers

There would be few, if any, institutional or legal barriers to this type of system. To be fully effective, though, there would have to be compatibility of AVI equipment so that vehicles from all over the country could be served. It would also require coordination between controllers of port/rail facilities and highway modes.

Financial Feasibility

This type of system could probably be financed through port user fees. It could reduce operating costs at the processing center by automating many of the functions. It could also result in lower operating cost for truckers using the port. The incremental cost of installing this equipment compared to the conventional equipment already used would be reasonable.

Attractiveness to Users. Operators, and Society

This type of system could provide significant benefits for all parties. Truckers could save time and avoid congestion through the use of this system. Operators could reduce congestion at their facilities and possibly reduce operating costs.

Human Factors Effectiveness

System should be relatively easy to use. In-vehicle displays could be used to convey information to drivers and guide them through the facility to their loading/unloading points. No major behavioral changes would be required on the part of system users, but informational displays should be clear and easily understood.

Potential for success

Potential for success should be fairly high. WIM and AVI systems are being tested as part of the HELP and ADVANTAGE I-75 programs and promise to offer substantial gains in efficiency for the trucking industry. Port and rail facilities should be integrated into these highway CVO systems for maximum effectiveness and to ensure compatibility of equipment.

Implementation Potential

Implementation potential should be high, although it may be more desirable in areas where CVO systems have already been implemented on local highways and compatibility of equipment can be assured.

SCENARIO 26 - REAL-TIME COORDINATION OF WATER TRAFFIC AND BRIDGE OPERATIONS

Description

In urban areas and on heavily traveled highways, drawbridge openings can cause serious delays to motorists. This is often compounded by two factors. First, by law, water and river traffic generally have the right-of-way, and bridges must be opened to allow ships and pleasure craft through. Second, there is often little or no coordination between the water traffic and the highway traffic. This scenario is intended to provide coordination between the two to reduce delays to highway traffic while minimizing impacts on river traffic. In this scenario, a central control facility would monitor both bridge and water traffic. Ships/boats would be organized in platoons so that they could be passed through several at a time, thus reducing the number of openings. Highway traffic would be alerted to the bridge openings via variable message signs and ATIS. Route diversion strategies would be implemented ahead of time to reroute traffic around the bridge and avoid congestion. If severe congestion already existed, the bridge opening could be delayed to allow traffic to clear.

Potential Benefits

The potential benefits to highway users would be reduced congestion and delay. Traffic managers would be able to avoid serious delays often associated with bridge openings.

Potential Costs

The system would require that ships/boats have some type of communication equipment and probably some type of AVL. Assuming that an ATMS/ATIS system is already deployed, the marginal cost for highway users would be low. This system, while potentially reducing delays for motorists, would likely increase delays for water traffic.

Institutional/Legal Barriers

It is likely that the greatest impediment to this scenario would be gaining Coast Guard approval to delay water traffic. Current laws state that water traffic has right-of-way and can not be delayed by highway traffic. This system would require some legal concessions from ship operators to permit their vessels to be queued and delayed when necessary.

Financial Feasibility

If the system uses existing traffic management systems, the additional cost for installation and operation should be fairly low.

Attractiveness to Users, Operators, and Society

This system would likely be attractive to highway users if it reduced congestion and delay around bridges. It would likely be unattractive to ships and commercial river traffic if it caused additional delay.

Human Factors Effectiveness

If the system used already implemented ATMS and ATIS systems for traffic management and route diversion, human factors effectiveness would likely be high.

Potential for success

The potential for success will likely depend on the ability to gain concessions from the Coast Guard and other commercial water traffic to permit the control of ship movements. If this could be obtained, the potential for success would be fairly high.

Implementation Potential

This scenario would have the greatest implementation potential in urban areas where even short bridge openings can lead to severe congestion. This scenario would probably not be justifiable in areas with low traffic volumes or infrequent water traffic.

SCENARIO 27 - MOVING URBAN GOODS ON FERRIES

Description	In many urban areas, traffic congestion is a serious impediment to goods movement. Traffic congestion delays shipments and reduces driver and fleet productivity. This scenario is designed to be applied to urban areas where severe congestion exists near bridges and tunnels. In some areas, private fleet operators have considered using ferries to bypass congested bridges and tunnels (Federal Express has considered using this in New York City). In this scenario, commercial vehicles would be directed to special ferries designated to carry commercial traffic. In-vehicle ATIS would guide the driver to the loading point, and AVI and WIM equipment would automatically identify, weigh, and bill each truck. Once on the opposite shore, the drivers would be guided to their destinations.
Potential Benefits	This scenario could reduce delays and increase operating efficiency for commercial operators. By removing heavy trucks and commercial vehicles from other bridge traffic, it could also help to reduce congestion at bridges and tunnels. It could also be used to make better use of existing ferry services during off-peak hours.
Potential Costs	If the service utilized existing ferries and terminals, the marginal costs could be relatively low. If it required new ferries, the costs would obviously be fairly high.
Institutional/Legal Barriers	There would not necessarily be any major institutional barriers to this scenario.
Financial Feasibilitv	Operating costs could be covered through tolls charged to each vehicle. Fleet operators could pay a flat rate or a "subscription price" for the service.
Attractiveness to Users. Operators, and Society	The scenario should be fairly attractive to fleet operators if it can increase the productivity of trucks. It could be attractive to ferry operators who could improve the utilization of their existing vessels. It could also be attractive to society if it reduces congestion and enhances the reliability of goods deliveries.
Human Factors Effectiveness	The scenario should be able to use already available ATIS, AVI, and WIM systems and therefore should be fairly easy to use from a human factors standpoint.
Potential for success	Potential for success should be fairly high in areas where vessels and terminals are already in place (e.g., New York City or Seattle). Success may be more difficult in areas where no infrastructure currently exists.
Implementation Potential	Scenario would most likely be implemented in high density urban areas with severe congestion problems and some form of ferry service already in place. This may be a good opportunity for a joint public-private venture between ferry and commercial vehicle operators.

APPENDIX B: DISCARDED SCENARIOS

The following are brief descriptions of selected scenarios that were examined but dropped from further consideration. A brief discussion is given of each scenario's intended purpose along with the reasons that it was dropped.

- **Pedestrian and Bicycle Access to Transit Centers** - This scenario was envisioned to provide dial-up route guidance, bicycle locker reservation, and automatic notification to transit authorities that a person would be bringing their bike on the system (many agencies require this type of notification before bringing a bike onboard). The system was seen as being useful particularly to bicycle couriers, who could then use transit for long deliveries.

- **Reason for Dropping:** This type of service would be more effective if integrated into a comprehensive multimodal trip planning system (see Scenario 18 - "Multimodal Trip Planning").

- **Travel Demand Reduction (TDM) Through Telecommuting** - Telecommuting could hold great potential for reducing travel demand either during times of incidents or emergencies, or as a general TDM practice. Under this scenario, employees would be permitted to work from home during air quality alerts, snow emergencies, or simply as a demand reduction measure.

- **Reason for Dropping:** Telecommuting may in fact provide substantial benefits in terms of demand management and congestion and pollution reduction. It was dropped not because it was not considered promising, but because it was not seen as the type of scenario that fell under the objectives of this study.

- **Shared Taxi Operation with IVHS:** - Shared taxi operation has been in use and tested for some time as a means of providing transportation services in low-density areas not well served by conventional transit. This scenario would have used IVHS technologies such as smartcards and in-vehicle ATIS to enhance its operation.

- **Reason for Dropping:** Shared taxi operations have met with some success, but their use and impact is difficult to predict, so this scenario was not considered a good candidate for operational testing. Since elements of this scenario are contained in other candidate scenarios, this scenario was dropped.

- **Monitoring Person Location on Bus/Transit -** On transit and passenger rail systems where smartcards are used, operators could know who was on each vehicle through the identity codes on the smartcards. This data could be used in several ways. It could be made available (through a controlled access system) to people waiting to pick up passengers so they could know with certainty which bus/train the person was on. It could also be used to provide valet parking service, for example. For a fee, passengers could have their arrival times transmitted ahead and have their cars retrieved from the lot and waiting upon arrival.

- **Reason for Dropping:** This system would be impractical for bus service, where passengers board and alight with great frequency. For commuter rail service this might be feasible, but its tangible benefits were seen to be limited, while the questions of privacy it would raise would be very serious.

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