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16. Abstract

The purpose of this study was to develop and evaluate concepts for a low-cost, practical motorist information system. The system is designed to accomplish the following:

- Meet motorist trip-related information needs.
- Utilize existing or emerging technologies.
- Have acceptable costs to motorists and government.
- Address institutional and regulatory constraints and the concerns of interested groups including motorists, government operators, system maintainers, manufacturers, commercial broadcasters and others in the private sector.
- Be achievable and practical when viewed from the above perspective.

The report includes an analysis of motorist information needs, a discussion of existing motorist information systems, a presentation of overall concepts designed to address motorist needs and an implementation plan describing how the concepts can be achieved. The motorist needs addressed by the concepts include traffic-related information, motorist services and attractions information, and information concerning the roadway itself. The concepts build on existing activities of both the public and private sectors and allow for the gradual integration of future technology into the system.

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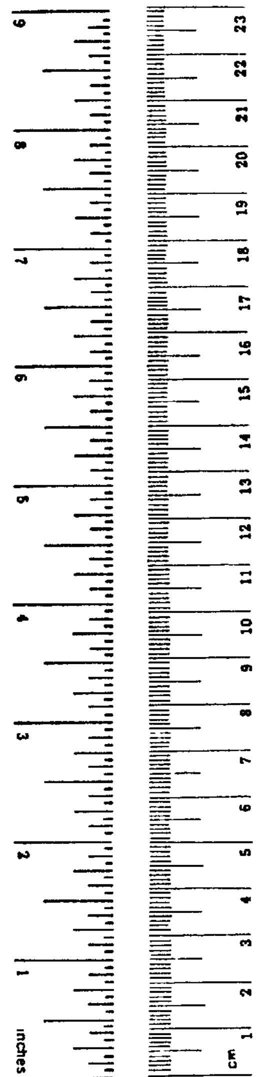
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

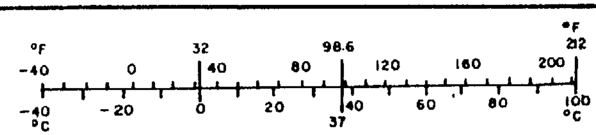
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

The purpose of this study was to develop and evaluate concepts for a low-cost, practical motorist information system. The system is designed to accomplish the following:

- Meet motorist trip-related information needs.
- Utilize existing or emerging technologies.
- Have acceptable costs to motorist and government.
- Address institutional and regulatory constraints and the concerns of interested groups including motorists, government operators, system maintainers, manufacturers, commercial broadcasters, and others in the private sector.
- Be achievable and practical when viewed from the above perspective.

The report includes an analysis of motorist information needs, a discussion of existing motorist information systems, a presentation of overall concepts designed to address motorist needs, and an implementation plan describing how the concepts can be achieved. The motorist needs addressed by the concepts include traffic-related information, motorist services and attractions information, and information concerning the roadway itself. The concepts build on existing activities of both the public and private sectors and allow for the gradual integration of future technology into the system.

OVERVIEW OF THE STUDY PROCESS

Three basic classes of information were identified as being within the scope of the study. These information types were based on the time-dependent nature of certain information needs, which could be logically grouped into three basic categories:

- Dynamic information (changes frequently and primarily includes information on traffic congestion and incidents).
- Semidynamic information (changes occasionally and primarily relates to motorist services, such as gas, food, lodging and attractions information).
- Static information (information which changes very infrequently, and includes information such as highway geometry on the road ahead).

Following the analysis of motorist needs, a review of existing and potential motorist information system components was conducted. It was found that motorist information systems can be functionally described in terms of three basic activities. These include:

- Collecting data.

- Consolidating and processing the data.

- Actual transmittal of the information to the motorist.

The review of existing systems and development of alternative motorist information system concepts was structured around these functional areas. The range of data collection, consolidation, and transmittal components were then evaluated, and the most promising components were packaged into conceptual systems (presented in Chapter 4). The conceptual systems were oriented around the three classes of information (dynamic, semidynamic, and static). The case study (included in a separate volume as Appendix B), illustrates how one of the concepts would be implemented in a local area.

RECOMMENDED MOTORIST INFORMATION SYSTEM CONCEPTS

A motorist information concept, as defined in this study, consists of a coordinated structure of data collection, consolidation, and transmittal components designed to meet specific motorist information needs. Four of these concepts were developed in this study, specifically addressing the dynamic, semidynamic, and static information needs. Two concepts were developed to address dynamic information, one for urban areas and another for rural and small urban areas. Semidynamic and static information were addressed by one concept each. The following sections summarize the key features of each concept. The concepts are shown functionally in Chapter 4.

- The concept for dynamic information in urban areas is oriented around a private traffic information service as the consolidation center. Freeway surveillance and control systems may also serve as an intermediate consolidation center or even as the primary center if coverage of an urban area with surveillance systems is complete. Key data sources will continue to be air- and ground-based observers, with the possibility of expanding the use of volunteer commuter contacts as a low-cost option. A wide range of transmittal media are possible. Traditional AM/FM radio broadcasting will continue to be used, and some possible enhancements of this medium are possible through the zoning of traffic information by participating radio stations and a more systematic scheduling of traffic reports. However, to make significant long-term improvements in the timeliness of the information, a dedicated traffic information radio channel will be needed. The most promising source for a dedicated radio medium is an FM SCA channel (see Chapter 3). The FM SCA channels were recently deregulated by the FCC, increasing the potential usefulness of this medium for purposes such as this, but special receivers will be required. Selected use of Highway Advisory Radio (HAR) and Citizens Band (CB) radio transmission at key locations are other low-cost transmittal methods to be considered in the near term.

- The consolidation operation for dynamic information in rural and small urban areas is designed around police operations, with possible assistance from State and local highway departments, depending on the institutional setting and allocation of responsibilities. The operation is designed to meet the sporadic needs for information which principally occur only during major incidents. Probable low-cost transmittal media include commercial radio, if available in that area, weather radio frequencies, and mobile HAR or variable message sign units.

- In the concept for semidynamic information, multiple consolidation centers are identified (e.g., auto clubs, travel agencies, and advertising firms), and a number of transmittal methods can be used. This information has high potential for application to electronic means, and a variety of electronic/computer-based methods are identified. However, most of these are not yet cost-effective in comparison with current methods (e.g., hard-copy travel guides). The data collection and consolidation process is likely to be largely a function of the private sector, with highway agencies continuing to have some involvement in the provision of information at rest areas and other information centers.

- For static information, signs will continue to be the predominant means of communication. Continued emphasis should be placed on logo signing and official business signing.

The concepts permit latitude in how intensively the Federal Highway Administration (FHWA) is involved. However, an active involvement by FHWA is important at the current stage of development, as both public agencies and private industry are in need of information about motorist information technologies and direction as to how the technologies can be applied in various institutional, geographic, and highway system environments. The most likely role for State and local highway agencies is to serve as initiators and coordinators for improvements to the motorist information system. The actual implementation of motorist information systems will be a combined responsibility of a variety of public agencies and private enterprise.

I. INTRODUCTION

The nation's motorists have always had a need for information on travel directions, road conditions, services, and other details involved with highway travel. However, the increasing complexity of the highway system, changes in vehicles, and the expectations of those who travel the nation's highways have highlighted the need for a more comprehensive, usable, and reliable means of providing motorist information. At the same time, advancements in communications technology and electronics have brought about a significant opportunity to improve methods of providing motorist information.

This requirement is somewhat analogous to the airline industry. As the complexity of the flight environment has grown, so have the systems for providing information to the pilot. Not only have complex guidance systems and in-flight information systems been developed, but detailed preflight data are available concerning path, weather, destination conditions, and other variables. These also allow the pilot to prepare and then guide the airplane safely.

Similarly, the motorist uses information to make decisions and guide the motor vehicle. He combines data from several senses and sources while making control and navigational decisions. The more effectively information is provided, the better the driving tasks can be performed. Ultimately, this leads to savings in travel time, improved safety, and greater comfort and convenience of travel.

There has been a great deal of effort in the past decade or more in developing and implementing advanced systems for motorist information. Also, the state-of-the-art in electronic roadway monitoring, communications, and data management is changing constantly. This provides additional opportunities for new applications. However, much of the recent research has been focused on a specific technology or application, and no overall view has been made of the basic needs of the motorist, and how they could be most effectively met through applying the advancing technologies. In recognition of this fact, FHWA initiated the study entitled "Concepts for a Low-Cost Motorist Information System."

The goal of this study as outlined by FHWA is to "develop a concept for a low-cost, practical Motorist Information System (MIS)." The system's development was to include consideration of emerging radio-based technologies, as well as other alternatives. The requirements placed on the recommended system are as follows:

- It must meet motorist trip-related information needs.
- It may utilize existing or emerging technologies.
- It must have acceptable costs to motorists and government.
- It must address institutional and regulatory constraints and the concerns of interested groups including motorists, government operators, system maintainers, manufacturers, commercial broadcasters, and others in the private sector.
- It must be achievable and practical when viewed from the above perspective.

HISTORICAL BACKGROUND

The provision of motorist information has long been recognized as a necessary adjunct to the provision of highway facilities themselves. Initial signing systems, although primitive, were installed to provide the motorist with essential information, primarily of a directional nature. Since trips were generally shorter and road systems were less complex in those days, motorists may have been more familiar with the sections of road they were travelling; the need for information was consequently less.

In the last several decades, this situation has changed dramatically. The construction of high-speed highways and overall expansion of the highway system, along with changes in land development, employment, housing, leisure time, and other areas of life, have resulted in increased long-distance travel, as well as increasing levels of congestion in many urban areas. Information about traffic, motorist services, and other aspects of travel have become more important to the motorist in order to optimize the time, safety, and convenience of travel.

Signing has been and continues to be the primary means of bringing information to the motorist. The Manual on Uniform Traffic Control Devices has been the primary governmental tool for bringing about a more comprehensive, uniform system of signing.[1] "Various research studies and practical experience have enhanced the standards and methods set forth in the manual. However, it has been only within about the last 15 years that a more comprehensive look has been taken at the information system in light of motorist needs.

One of the major studies to structure and identify motorist needs and relate them to the information system was NCHRP Report 123, entitled "Development of Information Requirements and Transmission Techniques for Highway Users,"[2] Driver task analysis was used to develop a hierarchy of driver needs, and these needs were used in identifying possible improvements to the signing system, as well as possible enhancements to the information system using other means of communication. This comprehensive study was built upon in other research primarily related to the signing system and including many areas other than those being considered in this report (e.g., regulatory and warning signs).

Interest in a comprehensive plan for motorist information increased in the mid-1970's with the passing of the Federal-Aid Highway Act of 1976, in which Congress specifically placed an emphasis on developing facilities, services, and programs for motorist information. This occurred partially in response to developments since the passing of the Highway Beautification Act of 1965. Concern was expressed over the need for information to replace some of the information being taken from the motorist as a result of the act, and also that the implementation of the act had been slower than desired due to the concern over voids that would exist without any replacement information. Subsequently, the Federal Highway Administrator established a task force to review the problems, and a study was conducted entitled "Options for Assuring Adequate Motorist Travel Information Systems" in May 1979.[3] In parallel with this effort was a comprehensive synthesis of the subject area entitled "Motorists Need for Services Information on Interstate and Federal-Aid Primary Highways."[4] The report described developments in providing pre-trip and enroute information via visual and audio means and suggested a prototype system for providing travel-related goods and services information.

Numerous other studies have been published dealing with particular aspects of the motorist information system, ranging from CB radio to variable message signing. Among the more comprehensive FHWA studies related to the subject area are: a user's guide on highway advisory radio systems, a study of freeway incident management which included motorist information aspects, a study of motorist-aid systems, and a study of human factors requirements for real-time motorist information displays.[5,6,7,8]

OVERVIEW OF STUDY APPROACH

One of the first tasks of the study was to develop a clear definition of a motorist information system and to clarify the range of types of information to be considered. A general definition is that a motorist information system is a "set of methods, devices, or procedures for providing the motorist with information useful in planning or conducting a trip."

This definition is quite broad and encompasses a wide variety of trip planning and enroute activities. It is, therefore, important to further define areas that will be within the scope of this study if a focus is to be maintained. The following constraints were developed to identify the activities not incorporated in this project.

- The system will not include information needed for "route-following" except as it relates to services-type destinations (gas, food, and lodging). (It will not tell the motorist which road to take to reach a certain city or town but will provide road condition information.)

- The system will inform the motorist how to reach emergency services, etc., should he have a problem. However, once a problem occurs, such as a vehicular breakdown, actually contacting the service becomes a motorist-aid problem and outside the scope of this study.

- It is assumed that the motorist has a map available which shows basic routes and destinations. Services and other trip-related information which could be useful in pre-trip planning was a topic of analysis in this study.

A "system" is an integrated series of components working together. In this regard, a MIS can consist of one or several subsystems each supplying different types of information or meeting different motorist needs. The conceptual system alternatives may use aural as well as visual means of communications. Factors to be considered in the development of the systems include motorist familiarity, levels of traffic congestion, highway facility type, range of in-vehicular electronics technology expected to be available, and many other factors.

Any motorist information can be functionally described in terms of three basic activities. These include:

- Collecting data.

- Consolidating and processing the data.

- Actual transmittal of the information to the motorist.

The motorist information systems discussed later in the report incorporate all of these aspects, and each has received a detailed focus in the analysis. Figure 1 shows the relationship of these components in a conceptual framework.

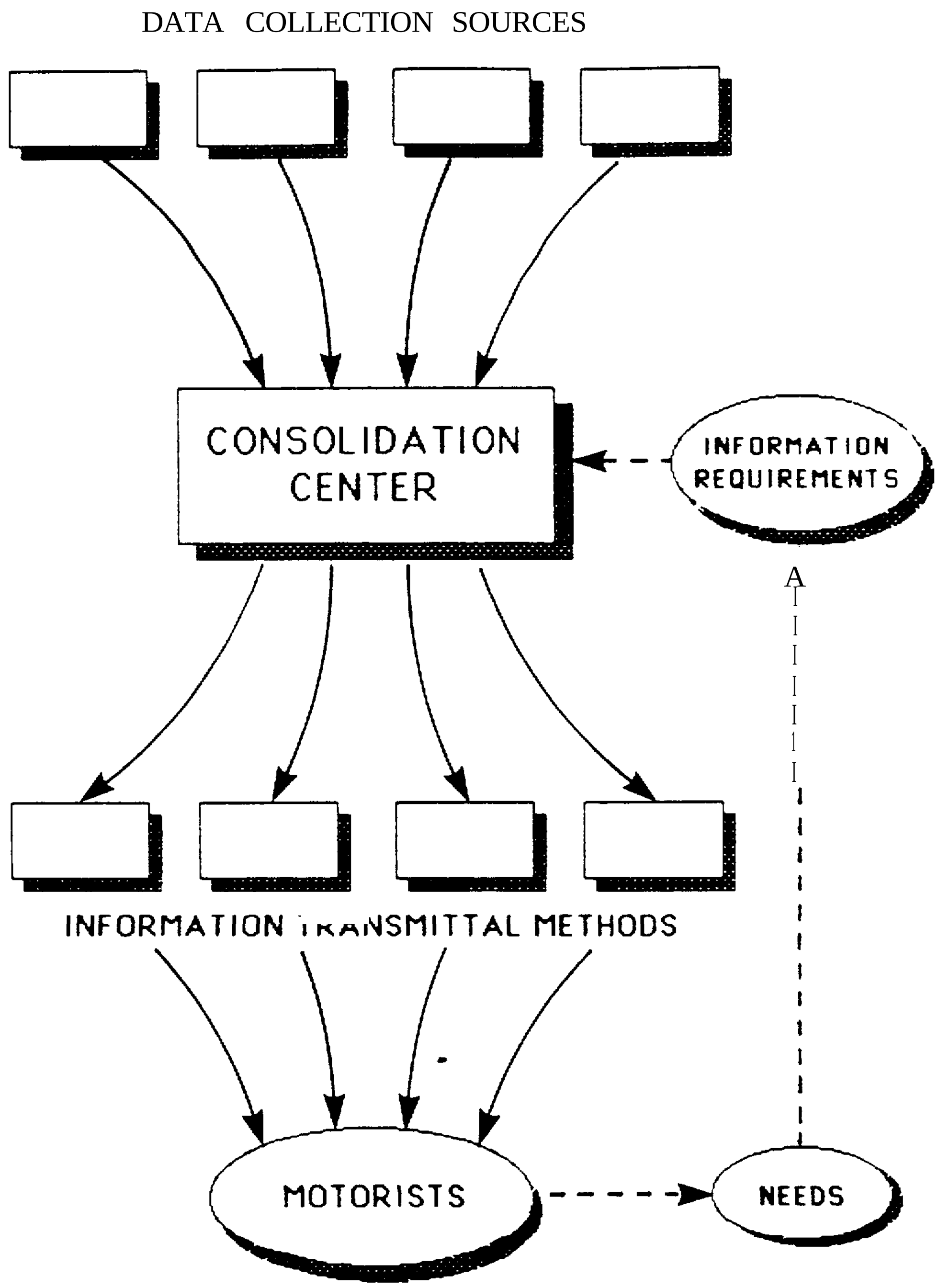
The study included a series of work tasks leading up to the recommending of MIS concepts and associated implementation activities. The tasks covered the following areas:

- An analysis of driver needs.
- An analysis of existing motorist information systems and how well they are meeting the identified needs.
- Development and evaluation of concepts for data collection, consolidation center operation, and information transmittal.
- Structuring and analysis of comprehensive MIS systems.
- Development of an implementation plan for the recommended system.

Chapter 2 presents a detailed discussion of driver needs. Chapter 3 identifies the range of existing systems, with an outline of the key characteristics of each. It also includes an evaluation of which system is oriented toward each driver need, how well the needs are being met, and institutional issues involved in various aspects of the systems. This serves as input to later tasks to determine where improvements to the current MIS systems are needed. In Chapter 4 individual MIS components are evaluated and integrated into comprehensive information systems addressing the motorist needs identified in Chapter 2. Chapter 5 summarizes the study findings, presents an overall implementation plan, and suggests a set of research needs. Appendix B presents a case study of how one of the concepts could be applied to a specific urban area.

Prior to addressing the motorist needs in Chapter 2, several of the more important issues should be discussed which influenced the direction of the study. One of the issues involved what was considered to be "low-cost" for the purposes of this study. Unfortunately, there is no clear-cut answer to this question. The provision of motorist information cannot be readily subjected to the traditional benefit/cost analysis which would enable this determinatioa to be objectively made. Many of the benefits of providing the information are not quantifiable in economic terms. One way to approach this problem from the viewpoint of the private sector is to evaluate low-cost in terms of whether the provision of such information is a marketable business enterprise; that is, will the motorist buy the service and will private enterprise be able to make it profitable? If these tests are met, then there must be some merit to providing the service.

In terms of public sector involvement, the assessment of what is low-cost is much more difficult. Here, the evaluation is much more relative, and involves the question of how much information the public sector is obligated to provide to the motorist. No clear-cut cost thresholds were specified in this study, but statements were made regarding what was low cost in relative terms. In addition, it was recognized that the relative costs of various motorist information system alternatives



Functional Diagram of a Motorist Information System

Figure 1

will change in future years as technology continues to evolve. Therefore, provision was made for including certain evolving technologies into the motorist information concepts even though they may not currently be low-cost.

Another important area already alluded to above is the allocation of responsibilities between the public and private sector in providing motorist information. The roles of the public and private sectors are not as clearly defined in the area of motorist information as they are for other areas of highway engineering. In this regard, the Task Force to Restudy Directional and Informational Signing, commissioned by the 1976 Federal-Aid Highway Act, noted increasing acceptance of the view that the highway agencies' ". . . overall responsibility for providing a safe, efficient, convenient, and economical highway system encompasses the specific responsibility for assuring that motorists using that system have adequate and timely information regarding goods, services, and facilities essential to travel, and recreational and travel-related interests that may be the purposes of travel." Thus, the public agencies' role could be described as one of providing essential information, as opposed to merely desirable information. The Task Force suggested that essential subjects included fuel, food, lodging, campgrounds, and emergency services. However, it is unclear as to which information about each of these subjects is essential (e.g., location may be considered essential, while the cost of the service may not).

Several other observations of the Task Force are relevant to this study. Six guidelines for providing a system of information identified by the Task Force also proved to be appropriate for this study. According to the criteria, the system should be:

- Comprehensive, in that it covers the full range of needs.

- A multimedia system, recognizing that no single source or information technique can meet all information needs in a timely, convenient, and economic manner.

- Coordinated, so that each medium and technique performs the function for which it is best suited within the total system.

- Incremental, making it possible for different levels *or* categories of information to be handled by differing options, and enabling the user to choose the level of information he desires and is willing to make the effort to obtain.

- A cooperative system, in which responsibility for providing the required information is shared by the public and private sector.

- A system with sufficient uniformity to assure easy general understanding and use by the traveling public.

The above guidelines are particularly appropriate in light of the complex and diverse settings in which the information system must operate. Many factors influence how the information is best provided, including local practices, driver preferences, and highway system characteristics. No one single method or solution will suffice for meeting all information needs. However, certain methods have been found to have advantages over others, and these will be highlighted in the report.

2. ANALYSIS OF MOTORIST INFORMATION NEEDS

DEFINITION OF MOTORIST INFORMATION NEEDS

A logical starting point for the examination of the technology of providing motorist information is to develop a concise definition of a motorist information need and to define the scope of needs being considered in this project. NCHRP Report 123 showed that driver needs may be classified into two broad categories: microperformance and macroperformance,

Microperformance needs are those related to basic driver tasks such as steering and controlling the vehicle safely. Macroperformance tasks are related to the planning and execution of a trip. They can also incorporate the driver tasks for being aware of the roadway environment and anticipating actions related to other traffic, weather, roadway obstacles, and similar conditions. These categories are in a hierarchical order of fulfillment, so that microperformance needs that arise must be fulfilled immediately and are given priority, while macroperformance needs are fulfilled at a secondary level.

For example, consider a motorist on I-95 between Washington and Baltimore, assuming a free-flow traffic condition. The driver may be concerned about which ramp to take to get to the Baltimore Harbor Tunnel - a macroperformance need. If another element is introduced, such as a car cutting in front of him, the microperformance needs come to the forefront. These microperformance needs, such as the vehicle's rate of deceleration and lateral placement, are far more important to the driver at that moment than which ramp to take several miles ahead.

For the most part, the motorist information needs to be addressed in this study are those included in the macroperformance region of this hierarchy, since the microperformance needs are primarily met by feedback to the driver from the vehicle operation and from immediate observations.

A working definition of a motorist information need was developed to guide the direction of the research and the investigation of systems to meet the needs. In developing this definition, it should be recognized that the priority of need for the information cannot be disassociated from the consequences of not meeting that need. For example, one might question whether certain items of information are truly needs in the same sense that food and water are needed for the survival of life. The consequences of not providing certain types of motorist information are not nearly as severe as things needed to sustain life. In this regard, the macroperformance needs are much less important than the microperformance needs, since the failure to meet a microperformance need may result in a life-threatening situation. Usually the failure to meet a macroperformance need simply means the loss of time and money and the experiencing of a less pleasant trip than would have been desired.

A "motorist information need," for the purposes of this study, is defined as any item of travel-related information which benefits the motorist. These benefits include reduced travel delay, improved safety through the knowledge of travel conditions, improved knowledge of travel amenities (e.g., vehicle services), and, in general, reduced uncertainties and increased comfort and convenience of vehicular travel. Some of the information items being considered in this study might actually be classified as wants or desires rather than as needs in the stricter definition of the word, since the consequence of not meeting the need may not be severe. However, for the purposes of this discussion, information will be defined as a need if it fulfills one or more of the travel-related objectives listed above.

BASIC STRUCTURE OF INFORMATION NEEDS

The first step in developing the list of driver needs was to review existing literature or previous research on the subject. The most pertinent was NCHRP Report 123, "Development of Information Requirements and Transmission Techniques for Highway Users." This report provided an excellent taxonomy of 120 needs stratified into eight categories. Although the NCHRP report is quite complete in terms of the different motorist information needs, it provides less detail as to the definition of each specific need, and approaches in more theoretical terms than is done here. The NCHRP report therefore served as a starting point, from which extensive redefinition and reorganization were conducted to meet the specific scope of this study.

The basic approach followed was to evaluate each of the 120 needs identified in NCHRP Report 123 to determine which ones were within the scope of this study. Several potential needs were ruled out immediately. In essence, most microperformance and traffic-situational needs related to the steering or speed of the vehicle itself were found to be outside the study scope. Similarly, needs related to the operational aspects of the vehicle (i.e., engine temperature, oil pressure, etc.) were seen as out of scope. However, such needs are pertinent once the vehicle condition becomes a concern to the driver, and he feels a need for a service station.

A further step in developing the list of driver needs was to look at existing information systems, with the question, "What need does this system or device meet?" This technique was used particularly on signs and other traffic control devices, since each of these has supposedly been engineered to fulfill specific information needs. Another focus was on radio-based systems including Highway Advisory Radio (HAR) and commercial radio, since these have been playing increasing roles in providing driver information in urban areas throughout the country. This was valuable in ensuring that the list of needs was comprehensive and practically-oriented.

Identifying needs which are not being met by current systems is more difficult. One way to identify unmet needs is to ask a question such as, "How do drivers voice their unmet needs?" One answer was to informally monitor CB radio broadcasts, since requests for information should be reflecting a need not met through other systems. This exercise resulted in two categories of needs being identified.

The first of these is the problem of destination locations, reflected in the question, "How do I get to . ..?" This concerns detailed locations which may not be on a map, or the driver may not have a map available. This need was included in the study, since it occurs enroute, and may be addressable in part through a low-cost system.

The other major need identified through the CB radio was the time and distance question, "How far/how long is it to my major destination?" This need can normally be met through the use of maps and the use of hand calculations concerning miles traveled and total distance and so was not included in the study.

Another way of identifying motorist needs was to mentally think through typical trips and the variety of circumstances which might come up during a trip, identifying information needs as they may occur along the way. All of the above techniques provided the basis for the information needs discussed below.

In reviewing the motorist needs, a major classifying factor was determined to be based on whether fulfillment of the need depends on data which is of a timely or changeable nature. It was found that data of a very "perishable" or timely nature required certain collection, consolidation, and transmittal procedures which were different from information which was less dynamic in nature. Examples of this include information concerning delays due to the incidents and the location and causes of temporary poor roadway conditions. Both must be accurate and reflective of the actual current conditions when they reach the motorist, even though they relate to two different needs. Therefore, a classification, based on the temporal nature of the information to meet the need, formed the structure of parts of the following analysis.

Three major categories were used:

Dynamic: This is information which changes frequently and often influences large groups of users. Also, it often requires a relatively small quantity of data to identify and describe the situation or condition. An example is a roadway incident during rush hour, where the presence, type, expected duration, and current and/or projected traffic impacts are critical. However, to be useful, the information must be collected quickly, and transmitted to motorists without delay. It should also be accessible at any time.

Semidynamic: This information changes occasionally, but the changes are often refinements or minor changes to the overall information. This information generally is applicable to only a small percentage of motorists at any given time, and there may be larger quantities of information necessary to meet the motorists' needs. An example is information on motorist services, where, although the location of the service generally does not change, characteristics such as operating hours and prices vary. It does not have to be accessible at any time, but the motorist must know when and how to access the information.

Static: This information changes very infrequently, but generally affects a broad group of motorists. There may be large quantities of information needed, but they will not often need amending. An example is the location of emergency services, or a telephone or rest area.

These terms will be referred to often in the following chapters. Within each of these three classifications, a number of motorist information needs have been identified:

Dynamic	Temporary Roadway Conditions Delay Causing Incidents Weather Information

Semidynamic	Vehicle Services Information Roadway Route Characteristics Overnight Lodging Information Parking at Major Generators Restaurant Information
Static:	Permanent Roadway Conditions How to Contact Emergency Services Non-Services Locational Information Speed Limits Location of Nearest Telephone Location/Distance to Rest Area Toll Information

IDENTIFICATION OF DRIVER NEEDS

The process of identifying motorist information needs yielded 15 distinct categories of needs within the three major subgroups. Each need is described below with a short title; whether the need may be met pre-trip, enroute, or both; and whether the target motorist is familiar or unfamiliar with the local road network. This last stratification is necessary because the information communicated to a person familiar with local streets (a message to a commuter, for example) would be very different from the message communicated with a long-distance traveler who is simply following an interstate route. The needs are described below, and summarized on Table 1 at the end of this section.

Temporary Roadway Conditions

This need is related to a temporary roadway condition that the driver otherwise would not expect. This may be the closing of a lane due to construction, the shifting of traffic across a median, slippery surface conditions, or poor visibility due to fog. An important characteristic of the need is the fact that the problem is temporary in nature. The need for a motorist to know variable, advisory speed limits is included here since the lowered limit is due to a temporary roadway condition,

Delay-Causing Incidents

This need is generated by nonrecurring traffic congestion that results in delays to motorists along a particular route. Since the commuter is well aware of the locations of recurring congestion, and recurring congestion reports to unfamiliar motorists is covered above, this need is directed to nonrecurring events. These may be relatively short lived, such as an accident, or affect traffic for relatively long periods, such as a roadway maintenance project. The objective of this information is to allow the commuter to take advantage of alternate routes to his destination.

The long distance driver is also frustrated by traffic congestion and would like information on how to avoid it. Of importance, therefore, is the capability of communicating the existence of an incident or a capacity problem at a point where the driver may have alternative route options, for both the commuter and long distance driver.

Weather Information

Many decisions are made based on current and forecast weather conditions. Whether to continue a trip or to stop for the night is a question that would likely be influenced by whether snow was forecast or not. In a pre-trip context, severe weather conditions, such as a forecast of a hurricane or blizzard, would likely be reason enough to postpone a planned trip for one or more days.

There are adequate weather forecasts available; therefore, this situation reflects more a need for consolidation of the weather data from existing sources and distribution of that which is important to drivers in a concise and timely manner. This is closely related to the temporary roadway conditions, which may be weather-related.

Vehicle Services Information

The need for information concerning vehicle services (fuel, maintenance) is normally seen as having two levels. The first level is when the vehicle is almost out of fuel or having maintenance problems. Here, the main information need is to find the nearest facility. The second level, when the motorist is in a situation which allows for choice, includes more specific information needs concerning the service facility, such as:

- Type of fuel (diesel, propane).
- Brand of fuel.
- Nearest open facility.
- Cost by grade of fuel.
- Ease of access and return to the roadway.
- Repair facilities.
- Credit card acceptance.

This information can vary by time of day and bay of week--for example, mechanics may not be on duty 24-hours a day, seven days a week.

Roadway Route Characteristics

On long distance trips, drivers frequently have several alternate paths that they may follow to their destination and choices as to departure time, rest stops, etc. Information in this category is designed to allow the driver to select the optimum path and plan the trip schedule based on the anticipated roadway conditions. Information in this category would include descriptive characteristics (two-lane, steep grades, beautiful scenic views); infrequent services; descriptions of long-term roadway construction and/or maintenance activities (bridge on Route 33 at the State line is under reconstruction, traffic delays of up to two hours may be expected); and normally recurring traffic delay conditions such as those which portions of typical expressways in large metropolitan areas experience in peak periods. A description of the character of the environment on routes in and around urban areas may be seen as important to selected groups of motorists.

Overnight Lodging Information

Motorists use several criteria to select a place to sleep for the evening. These criteria include franchise name, cost, amenities (pool, restaurant), and availability. Notice that two of the criteria above are constant (franchise and amenities). Cost, however, frequently changes as a result of demand and inflation. The fourth criteria, availability, varies by time of day. Implicit in this need, therefore, is the ability to update information in real-time for the cost and availability criteria.

Motorists normally plan longer distance trips in advance. To those who plan ahead, the overnight lodging availability information may be a pretrip need. Others drive until overcome by fatigue, and to these motorists this need would manifest itself enroute.

Availability/Cost of Parking, Other Information on Major Generators (Destinations)

Much consideration has been given to the vehicle, roadway, and driver in the pre-trip and enroute stages. Little consideration has been given to the needs at the end of the trip, specifically the availability of parking and the cost of parking the vehicle at major destinations.

In recent years, destinations with limited or restricted parking facilities, such as airports and recreational centers, have recognized this information need and have attempted to communicate with the driver using changeable message signs and highway advisory radio. As facility demands grow, this type of information will become more important.

Restaurants Information

As with the selection of service facilities, the driver may be expected to select restaurants based on various criteria. Example criteria include type of restaurant (fast food, sit-down), restaurant name, cost information, credit card acceptance, and ease of return to freeway.

Permanent Roadway Conditions

This need relates primarily to geometric features of the highway. The key factor in defining this need is a roadway condition that the motorist would not expect. For example, a sharp horizontal curve hidden by a vertical grade would not be expected by the driver in an area of level terrain, but would be expected in the mountains. Hidden railroad crossings and sudden lane drops are further examples of this information need. Static highway signing has almost always been used to provide the needed information.

How to Contact Emergency Services

The potential to be involved in or witness an accident **or** to have some other type of situation arise which requires medical or other emergency service exists for all drivers on all types of trips. This need would be to provide the information necessary to contact emergency services. This requirement is for information on how to contact or travel to the appropriate agency or location, not the mechanism to achieve the communication (which would be part of a motorist-aid system). Examples of emergency services are hospitals, trauma centers, and local police.

Non-services Location Information

It has been estimated that at least 50 percent of the practical information requested and transmitted on the CB radio falls into this category. This need is characterized by "How do I get to . .." The possible destination ranges from a specific street address to sports stadiums.

The need for reaching non-services destinations is perhaps the most pervasive of all the needs identified. For purposes of this study, it will be confined to major destinations such as recreational, entertainment, camping, government complexes, and others which have been incorporated in current highway signing.

Speed Limits

Although there is a nationwide maximum speed limit of 55 mph, there are many situations where speeds are posted lower. The travelling motorist has a need to know the legal speed limit. This information need exists primarily in speed zones. In general, the speed limit need applies equally to familiar and unfamiliar drivers.

Location of Nearest Telephone

The only practical means of long distance, real-time communications is by telephone. Until the day when most vehicles are equipped with a mobile phone - a time which may be in the foreseeable future - there is a potential need for the motorist to be able to find a telephone.

Location of Rest Areas

Anyone who has ever traveled with children will appreciate this motorist information need. The information need includes a description of the facilities available (restrooms, picnic areas, drinking water, etc.), as well as the distance to the facility.

Toll Facilities

Many toll facilities have exact change lanes. In order to effectively use these lanes and minimize delays to motorists, it is necessary to know what the toll is and what lanes to select to use the automatic facilities. These data are included in this information need.

PRIORITIZATION OF DRIVER NEEDS

The final step of this initial task was to assign a priority to each of the 15 needs. A relatively simple system of A, B, and C was used, with A being needs of high priority, B a medium level of priority, and C of lesser priority. Priority here is seen as meaning "of immediate importance to the motorist." Information needs that are related to safety and delay were considered of highest priority especially when the need was considered to be widespread. Needs with safety and delay implications that occurred less frequently were given a "B" priority. "C" priority needs are those which are useful but with less serious implications for nonfulfillment.

Each need was evaluated as to when the need should be met, either pre-trip or enroute. Some needs may be met during both parts of the trip. The target audience was also identified. These categories were either persons familiar with the road network (commuters are typical) or unfamiliar (long distance travelers). Again, some needs apply to both categories. There may also be special groups and situations, such as older persons or motorists driving alone, where a need would take on special significance. These will be highlighted in the analysis where appropriate. As shown on Table 1, there are three needs with an "A" priority, five needs with a "B" priority, and eight needs with a "C" priority.

Table 1. Motorist Information Needs

Motorist Needs	Priority * of Need	When Occurs (Pre-Trip/ Enroute)	Type of Motorist (Familiar/ Unfamiliar)
DYNAMIC INFORMATION			
Temporary roadway conditions (slippery surface, poor visibility, construction zone)	A	Both	All
Delay-causing incidents (traffic-related)	A	Both	All
Weather information	B	Both	All
SEMIDYNAMIC INFORMATION			
Vehicle services information	B	Enroute	All
Roadway route characteristics	B	Pre-Trip	Unfamiliar
Overnight lodging information	C	Both	Unfamiliar
Availability/cost of parking, other information on major generators (destinations)	c	Enroute	All
Restaurant Information	C	Enroute	Unfamiliar
STATIC INFORMATION			
Permanent roadway conditions (geometric)	A	Enroute	Unfamiliar
How to contact emergency services	B	Enroute	All
Non-services locational information	C	Both	Unfamiliar
Speed limits	C	Enroute	All
Location of nearest telephone	C	Enroutc	All
Location/distance to rest area	C	Enroute	All
Toll information	C	Enroute	Unfamiliar

*Priority Codes:

A= High, recurring
B= High, occasional (situational)
C = Useful

3. EXISTING SYSTEMS ADDRESSING MOTORIST NEEDS

It is necessary to have a thorough understanding of existing motorist information systems in order to develop an effective and practical concept for a system. Thus, the purpose of this chapter is to provide a comprehensive review and examination of those systems which are currently meeting the needs of travelling motorists. The chapter first examines methods currently used within each of the functional areas: data collection, consolidation, and information transmittal. Next, an evaluation of how well the systems are meeting motorist needs is presented, and conclusions are then drawn concerning deficiencies in current systems. The chapter concludes with a discussion of institutional constraints.

DATA COLLECTION

The collection of data is the initial step in providing information to meet motorist needs. Data are the basic facts and observations which, when refined and processed, become information. The data collection aspect normally involves two general steps:

- Actual collection of the data.
- Transmittal of the data from the source to a consolidation center.

First, the data required to meet the motorist needs are identified and examined in terms of their characteristics. Then, various methods for collecting data are described. This is followed by a discussion of the groups which are currently involved in the collection of data useful for motorist information. Finally, methods of transmittal of the data to the consolidation center are identified and described.

Data Required to Meet Motorist Needs

Each of the motorist needs requires one or several types of specific data. This data can be collected by different groups and has characteristics which must be considered when analyzing the procedures. Table 2 lists each of the motorist needs separately and identifies the individual data -required. In cases where there is a difference between an urban and rural environment, this is noted.

In the tables, the definitions of the headings and ratings are as follows:

Current Collectors: These are the basic organizations or sources of the data. The abbreviations used are as following:

DOT = State or local departments of transportation, or traffic engineering

Police = State or local police

Spec. Road Athy. = Special roadway authority (Toll Road, Bridge)

Auto Clubs = Automobile or touring clubs

Guides = Publishers of maps, guides, and directories

Pvt. Traffic Svc. = Private traffic services

Motorist = Other roadway users, in autos or trucks

Transit Athy. = Transit authority

Weather Svc. = National Weather Service or private weather service

C of C = Chamber of commerce

Chains = National or regional service, hotel, or restaurant chains

Indiv. Bus = Individual businesses

Each of these groups are fully defined and discussed in a later section of this chapter.

Format: This is the form in which the data is primarily found. Some data can only be collected from observation of a physical situation on the roadway **(field condition),** while some have generally been previously reduced to a stored format **(records),** which could be computer records or hard-copy. Some data is primarily based on human knowledge or judgement **(personal knowledge)** from observing a variety of conditions over a long period of time.

Current Availability: This is a measure of the general availability of the data based on current data collection procedures being used across the country. It relates to the availability of the data and not whether it is being used for motorist information. Good indicates the data is almost always being collected and is readily available; **fair** indicates it could be obtained, but with some special provisions required; and **poor** means it is not generally available without extensive efforts.

Rate of Change: This measures how fast the data changes. **Rapid** would mean it changes on a hourly basis; **medium** would change monthly; and **slow** change is less often than monthly.

Summary

Breaking each motorist need into specific data required to meet the need is essential to the analysis. Most motorist needs are fulfilled with several data components, each of which has its own characteristics. These characteristics, including rate of change, general availability, and format, can vary among data components within a need. Therefore, the analysis of data collection was begun with a focus on the individual data item.

Table 2 highlights the wide variety of data needed to provide information for motorist needs. The data differs in its current format from State to State and between rural and urban areas. Nevertheless, many groups are concerned with its collection, and in every case one or more groups are involved with the data.

Table 2. Data to Meet Motorist Needs

Motorist Need (Priority)	Data Required	current Collectors	For that	Rate Of Change	Current Availability
Temporary Roadway Conditions (A)	Temp. detour or lane shift (location, duration, motorist action required)	DOT, Spec Rdwy. Athy.	Records Field Cond.	Med.	Urban: Fair Rural: Poor
	Temp. hazardous non-environmental condition-debris, pothole (location, motorist action required)	DOT. Police, Spec. Rdwy. Athy. Pvt. Traffic Svc., Motorists	Field Cond.	Rapid	Urban: Fair Rural: Poor
	Temp. hazardous environmental cond-slippery surface, poor visibility (location, severity).	DOT, Police, Pvt. Traffic Svc., Transit Athy., Weather Svc., Motorrsts	Field Cond.	Rapid	Urban: Fair Rural: Fair
Delay Causing Incidents (A)	Location and type Of incident or condition	Police, Pvt. Traffic Svc. Motorists, Transit Athy.	Field Cond.	Rapid	Urban: Good/Fair Rural: Fair
	Impact on traffic, expected duration, motorist actions required	Police, Pvt. Traffic Svc.	Field Cond. Pers. Know.	Rapid Rapid	Fair
	Alternate routes	Police, Pvt. Traffic Svc., DOT	Records Pers. Know.	Rapid	Poor
Weather Information (B)	Current and forecast weather cond.	Weather Svc.	Records	Med.	Good
	Hazardous weather advisory or warning	Weather Svc.	Records	Rapid	Good
Vehicle Services Information (B)	Facility location and name	DOT, Chains, Auto Clubs, Indiv. Bus.	Records Field Cond.	Slow	Good
	Facility characteristics (hours, types of fuel, credit cards)	Chains, Auto Clubs, Indiv. Bus. (DOT)	Records Field Cond.	Med.	Fair
	cost	Indiv. Bus., Chains	Field Cond., Records	Med.	Fair
	Ease of access	DOT, Auto Club	Field Cond.	Slow	Fair
Roadway Route Characteristics (B)	General Roadway and Environment (Type of roadway, scenery, frequency of service. terrain travel speeds, urbw areas encountered)	DOT, Auto Club, Spec. Rdwy. Auth., Guides	Records Field Cond.	Slow	Good
	Long term detour and construction	DOT, Auto Club, Spec. Rdwy. Auth.	Records Field Cond.	Med.	Good
Overnight Lodging Information (C)	Location and name of accomodations	Chains, Auto Clubs, Guides, C of C, Indiv. Bus. (DOT)	Records Field Cond.	Slow	Good
	Accomodation characteristics (type, amenities)	Chains, Auto Clubs Guides, C of C, Indiv. Bus.	Records Field Cond.	Slow	Good
	cost	Auto Clubs, Chains, Indiv. Bus.	Field Cond. Records	Med.	Fair
	Room availability	Chains, Indlv. Bus.	Field Cond. Records	Rapid	Fair/ Poor

Table 2. Data to Meet Motorist Needs (Cont'd)

Motorist Need (Priority	Data Required	Current Collectors	Format	Rate of Change	Current Availability
Parking at Major Generators (C)	Parking locations	Indiv. Bus., Auto Clubs	Records	Med.	Good
	Parking cost	Indiv. Bus.	Records, Pe Know.	Med.	Good
	Parking availability and alternative locations	Indiv. Bus.	Field Cond. Pers. Know.	Rapid	Fair/ Poor
Restaurant Information (C)	Location, type, and name of restaurant	Chains, Auto Clubs, Guides, Indrv. Businesses (DOT)	Records	Slow	Fair
	Restaurant characteristics (hours faire, credit cards, cost).	Chains, Auto Clubs, Guides Indrv. Bus.	Records Field Cond.	Med.	Fair
Non-Services Location Information (C)	Location, general route to nearby attracttons and generators	C of C, Indiv. Bus. Auto Clubs, Guides (DOT)	Records Field Cond.	Slow	Fair
Speed Limits (C)	Maximum legal speed limit	DOT, Spec. Rdwy. Athy.	Records	Slow	Good
Permanent Roadway Conditions (A)	Hazardous locations (sharp curves, RR-xing, lane drops, etc.)	DOT, Spec. Rdwy. Athy.	Records Field Cond.	Slow	Fair
How lo Contact Emergency Svcs. (B)	Telephone, Call Box location	DOT, Spec. Rdwy. Athy.	Records	Slow	Fair
	Type, location of emergency services	DOT, Spec. Rdwy. Athy.	Records, Field Cond.	Slow	Urban: Fair Rural: Poor
	CB channel monitoring by police, or volunteers	DOT (Police, volunteer groups)	Records Pers. Know.	Slow	Fair
Location of Nearest Telephone (C)	Location, availability of telephone (on or near roadway)	DOT (Telephone Co.s)	Records Field Cond.	Slow	Fair
Location of Rest Area (C)	Location (distance) to next rest area	DOT, Spec. Rdwy. Athy., Auto Clubs, Guides	Records Field Cond.	Slow	Good
Toll Facilities (C)	Location of barriers, cost	DOT. Spec. Rdwy. Athy. Auto Clubs, Guides,	Records	Slow	Good
	Configuration of lanes for exact change	DOT, Spec. Rdwy. Athy.	Records	Slow	Poor

Some patterns concerning the data can be seen. Dynamic data is most difficult to collect and not highly available since it requires frequent observation. The groups most involved are the police, as part of their normal incident management activities, and private groups concerned with supplying the information to motorists in urban areas (with a profit motive).

The semidynamic data is often available in a record, either written or computerized. Where it has been consolidated, as with auto clubs and guides, it must be obtained pre-trip. Chains and individual generators/attractors know only about their particular activities.

The static data changes very infrequently and is generally in a record form. Except for signs, however, it is not in a comprehensive format; it is obtainable only in a given geographic area (each telephone company knows where its telephones are but not about those of other companies). Because of this, the general accessibility is only moderate.

Data Collection Methods

Data used to provide motorist information may be gathered in four basic ways: observation, monitoring, inquiry, and reception of information. Each of these methods is discussed in the following section in terms of the different techniques within each method and their accompanying characteristics. Table 3 also contains a summary of key characteristics of each method.

In Table 3, the following characteristics are used to describe the collection methods. In all of these, the general viewpoint is that of the data collection agency, which is often a consolidation center.

Type of data: For each of the three major types of data, the methods vary in their suitability for use. Some methods are useful for initial collection of the data, which is identifying and collecting the data without prior notice from other sources. Verifying, on the other hand, is used to check on the accuracy or provide more detail to data already supplied by another source. Some methods are best used for one or the other of these activities, while most can be used for both.

Control by primary collector is an indication of whether the collection agency or group can control the collection and transmittal of the data. In some instances the collection is directly controlled by them, since it is being conducted by their observers or equipment. In others, they initiate a request or establish an standard operating procedure and so have indirect control. In some cases, they must simply wait for others to provide the data, and so have no control (none).

Relative cost is a measure of how much it costs the collection agency to obtain the data. This is a direct function of the labor required by the agency, except in the case of electronic observation in which the capital costs are a major expense. For observers who are directly controlled and paid, the costs are high Moderate requires some labor but not the same level of effort as observation. Low means that the persons at the agency can conduct other normal activities. Data collection requires only a small portion of the time, with little initiation required on their part.

Table 3. Data Collection Methods

Method	Type of Data+			Control by Primary Collector	Relative cost	Applicability to Rural Environment
	Dynamic	Semi-Dynamic	Static			
Observation						
Fixed Observers	c - v			Direct	High	No
Mobile Observers	c - v	c - v	V	Direct	High	Yes
Airborne Observers	c - v			Direct	High	No
Detectors	c			Direct	Very High	No
CCTV	c - v			Direct	Very High	No
Monitoring						
CB Radio	c - v			None	Low	Limited
Emergency Services	c-v			None	Low	Yes
Inquiry						
Research		c	c	Direct	Moderate	Yes
Written/Verbal		c - v	c - v	Indirect	Moderate	Yes
Reception						
Routine Reports		c	c - v	Indirect	Low	Yes
Procedure Reports	c - v	c - v	c - v	Indirect	Moderate	Yes
Individual Reports	c	c		None	Low	Limited

* C = Initial Collect
V = Verify other data

Applicability to rural environment is used to identify methods which can be used outside of urban areas, Virtually every method is usable in an urban setting, so the identification of methods for rural areas is important.

The following are brief discussions of each of the methods. At the end of the section, a summary highlights findings from the descriptions and analysis.

Observation

Observation is a highly reliable method of data collection which is best utilized to gather dynamic and semidynamic information. It can be used for both collection and verification of information, but since it is highly labor intensive, it can be quite expensive. From a motorist information perspective, labor costs can be minimized through the use of personnel whose primary task is other than observation; however, the responsibility of reporting on existing conditions may interfere with their main duties. There are two ways to gather information using observation; personal observation and observation by electronic means. Personal observation can be made by either fixed or mobile observers.

Fixed observers may be utilized to gather dynamic information at a specific location. They commonly provide reports on traffic and roadway conditions to local traffic services in urbanized areas. Normally, observers report from locations of recurring congestion such as a toll barrier, a bridge, or a particular section **of** a highway. Often, observers are stationed in tall buildings from which a large portion of the street network is visible. Although many observers are specifically employed for this purpose, others whose primary task may not be observation can be used to gather data. For example, a person who works at a toll barrier may be able to provide information concerning the current length of delay. Fixed observers can provide accurate, real time information which can be updated frequently. Their comprehensiveness varies with the amount an individual can physically see, although coverage is improved if many observers at different key locations are used.

Mobile observers can gather both dynamic and semidynamic information. In fact, all types of information can be obtained and verified by mobile observers, although personal observation is not always the best means of data collection. For example, static information, such as speed limits or rest area locations, is much more effectively obtained from existing records or maps. Mobile observation can be made from both the ground and the air.

Surface observers are able to report on conditions along the roadways on which they travel. Some traffic services employ these observers to report on rush hour traffic conditions (congestion and delay) and/or roadway conditions (snow or ice coverage) in urban areas during inclement weather. In limited numbers, they cover a relatively small area and observe a particular facility for only a short period of time. Mobile surface observers employed by touring services, guide book publishers, and some departments of transportation have quite a different function. These persons travel large geographic areas collecting and verifying services and accommodations information in order to keep their employer's documents and maps accurate and up to date. The extent of coverage area results in a significant time lag. Ideally, the amount of time between visits corresponds to the time for changes to occur.

As with fixed observers, there are many persons on the ground whose primary task results in their observation of traffic and roadway conditions. These include police on vehicular patrol, bus drivers in route service, and road maintenance personnel conducting snow removal or abrasives application. Their potential lies in their presence on many highways which would enable them to provide fairly comprehensive coverage. Their reports could be most efficiently obtained through their central reporting point (supervisor or dispatcher). Commuters who travel the same route daily can also be a cost effective method, but require a means of communication with the consolidation center.

Airborne observers are commonly used for rush hour traffic condition observations in metropolitan areas. The high cost of the airplane **or** helicopter operation is offset by the comprehensiveness of the coverage. However, there is a certain time lag involved between updates for a particular facility which varies directly with the size of the geographic area covered.

Electronic means permit observation of an area or facility from a centralized, remote location. This method is best utilized to collect dynamic traffic data although the records generated from the data could be used to provide other information, such as locations of recurring congestion. The initial capital cost is extremely high relative to other data collection methods; however, the personnel requirements are much less. The two devices normally used for collection are detectors and closed circuit television (CCTV). Each can be used alone, but they are often coordinated together, especially in large freeway surveillance and control systems.

Detectors embedded in the roadway typically provide volume and percent occupancy information. The occupancy may be defined as the percentage of time a vehicle is above (occupying) a detector. From these data, other indicators of the degree of congestion, such as average speed may be derived. Thus, by placing detectors along the length of a facility (a typical spacing is one-half mile), locations of slowdowns or incidents can be identified. The identification process can be accomplished by a computer using comparison algorithms containing various decision trees. Measured and derived data are compared with historical data and, in some cases, with data from up and downstream detectors. The comparisons are normally made utilizing threshold values. When the proper combination of exceeded threshold values is identified (and various error checks prove negative), the system will alert an operator to a potential problem. The operator then must attempt to verify the problem through CCTV, CB or emergency services monitoring, or other means and then take appropriate action.

Closed circuit television can be used to observe traffic conditions through the use of remotely controlled high-mounted cameras placed at strategic locations. If CCTV is used alone, it requires a great deal of attention by the operator(s). Its use is also limited during night or other periods of limited visibility. Therefore, this method is best suited to verification of information provided by other means, such as electronic sensors or CB radio monitoring. Using CCTV for verification allows the operator(s) to perform other tasks and duties, and focus on the CCTV screens only when alerted by other methods to a potential incident.

Monitoring

This method consists of listening to others who are making observations or being given instructions concerning conditions or incidents on the roadways. This pertains primarily to monitoring citizens band radio and emergency services frequencies. A relatively low cost method, it can best be used to both gather and verify real time traffic information in urban and rural areas. Several existing surveillance and control systems use monitoring as their means of verification rather than the more expensive (although more reliable) CCTV. Since those monitored are not usually trained in reporting traffic conditions, the information obtained must be used with some degree of caution. For example, a motorist who comes upon a traffic backup may state that "there must be an accident up ahead," when, in fact, it may only be a brief problem caused by a temporarily stalled vehicle.

Citizens band radio monitoring can be used to gather motorist information through the use of listening posts. Since the range of a typical CB radio is a radius of approximately 5 mi (8 Km), these posts must be strategically placed throughout an area to provide comprehensive coverage. The CB receivers at the listening posts can be individually manned or electronically connected to a central location. Much of the information broadcast on the common channels, however, is extraneous "chatter" and reduces this method's attractiveness as a primary collection method since it may be difficult to select useful information. One efficient method is to utilize a CB radio as a verification source, listening only when another method indicates a potential problem.

Emergency services radio monitoring consists of listening to communications between central dispatchers and units located in the field. Police are the primary source of this information since they are the most numerous, are spread across large geographic areas and usually are the first contacted in the event of an accident *or* other problem. Police have more responsibilities than just handling traffic **or** roadway-related problems; and, as such, only a limited percentage of all communications broadcasts would be of interest to a motorist information system. Therefore, as with CB monitoring, useful information would have to be sorted out.

Inquiry

An active method for data collection, inquiry consists of seeking out data for motorist information. Virtually any type of semi-dynamic or static data may be obtained through this method. One may gather someone else's knowledge using written **or verbal communciation** or simply obtain information through research. Generally, the information collected by this method is reliable; however, some data obtained from others would probably require some type of verification. If the verification process is not too costly, acquiring information from someone else can be relatively inexpensive, while research can be quite the opposite.

Research varies in complexity. It can be as simple as looking up hotel or restaurant locations in the yellow pages or as complex as a detailed research project concerning roadway characteristics. Obtaining information through written or verbal communciation is effective in gathering special information or obtaining data for the first time. The contact with the information source could be through either a letter, phone call, or personal meeting.

Reception

This method consists of providing a means of receiving data from sources. All types of information may be collected using reception, although the reports received must be previously arranged in some manner. In other words, the information source must know that the receiver desires the information and that the data is received (e.g., the phone number to call). Reports can be of three types: routine reports, procedure reports, and random reports. Reception is a low to moderate cost data collection method. The cost varies with the type of transmittal and receiving techniques utilized. Manual techniques are labor intensive, while highly automated systems can have large initial capital costs. The method is fairly reliable because it only requires occasional verification since it is a recurring process.

Routine reports are reports which are received on a regularly scheduled basis. For example, each month, a State department of transportation would send a list of all construction, maintenance, and detour information in the State to a consolidation center. After the initial set-up concerning the format and timing, these reports would be received without a specific request. By their nature, they are best for semi-dynamic information. Any dynamic information which is routinely received (i.e., 15-minute intervals) would probably have been collected by some type of observations; thus, it is not included here.

Procedure reports are reports which are communicated as part of a standard operating procedure. For example, a police dispatcher might have a specific duty to notify a consolidation center immediately of any accidents on a major arterial of which the police are aware, or a REACT volunteer knows to call the DOT with roadway condition reports during a snowstorm. These differ from routine reports in that their transmittal would be only upon the occurrence of certain conditions with no set schedule. All types of data can be collected using this method. The dynamic information would mostly deal with incidents; semi-dynamic and static information would be reported whenever a change occurs.

Indiv idual calls or reports are unsolicited; however, the reporter is aware that the consolidation center desires the information and knows how it can be contacted. Examples of this are departments of transportation which advertise a "pot hole reporting" phone number or police departments which receive phone calls from motorists who have seen a roadway accident. Again, this method can be used to gather all types of information, although the reliability would depend upon the type of reporter. Other calls from motorists need verification and further investigation.

Summary

In summary, there are a finite number of methods available for collecting data concerning motorist information needs. Each of these has advantages and disadvantages which make them best suited for certain applications.

- Direct Observation: Labor intensive, but it provides details and characteristics as they actually exist at the time. It is essential for dynamic data, but can be useful for semi-dynamic and static data.

- Electronic Observation: A large capital expense is required to establish this method which also may have high operating expenses. However, it can provide a great deal of dynamic data concerning traffic conditions. It is only justified on high volume facilities.

- Monitoring: An inexpensive method, since it is a passive activity. It is most effective for verification of dynamic conditions.

- Inquiry: This method requires labor, since it is an active method. It works best with pre-established contacts; well suited for all types of information, but especially for semi-dynamic and static data.

- Reception: A passive, inexpensive method, dependent on pre-established communication links and on the willingness of others to respond. It is useful for dynamic and semi-dynamic data.

Data Source Groups

A review of the current motorist information systems and the data needed to meet motorist needs allows for the categorization of groups which could, or should, be involved with data collection. The following narrative describes the overall scope of activities of each of the data sources. Also incorporated are comments on key characteristics, which include:

- Whether the organization is generally public (governmental operation) or private (normally for profit, occasionally private, not-for-profit).

- Whether the source is found in urban, rural, or both types of areas.

- How pervasive the organizations are on a national basis.

- The normal extent of automation of activities.

This information serves as an overview of the detailed characteristics found in Table 4. This table highlights the data collected as part of each of the source's major responsibility areas and how the data is collected. The data collection methods identified are those discussed previously in this chapter. Also in the table is an identification of the level of the organization at which initial consolidation of the data occurs.

State Departments of Transportation

These public agencies are found in all the States of the country. They have responsibility for the construction, operation, and maintenance of roads, signs, and traffic control systems, normally in both urban and rural areas. They frequently are also responsible for State and local highway maps, rest areas, and installation of services logo signs (some 23 States have or are planning to begin a logo signing program). These responsibilities were shared between central headquarters and a structure of district and local offices. These responsibility areas provide the State DOT's with extensive knowledge of motorist-related data.

Table 4. Data Source Characteristics

Source Group	Primary Responsibility	Data Collected	Collection Method Used	Consolidation Levels
State Departments of Transportation	Construction	Inventory of existing roads and their characteristics.	Routine reports	State, District
	Maintenance	Location of detours and maintenance operations	Routine and procedure reports	State, District, Local
		Roadway conditions during inclement weather	Procedure reports, mobile observattons	State, District Local
	Operations	Knowledge of travel environment	Routine and procedure reports, mobile observations, individual reports	
		Locations of recurring congestion	Mobile observations, individual reports	District, Local
		Services locations	Inquiry, mobile observations	State, District
		Location of toll facilities	Routine reports	State, District
		Location of major incidents	Procedure reports	District
	Mapping	Location of major generators, rest areas, road types	Routine reports, inquiry mobile observations	State, District
Local Traffic Engineering Department	Construction	Inventory of existing streets	Routine reports	Local
	Maintenance	Location of detours and maintenance operation	Routine and procedure reports	Local
		Roadway conditions during inclement weather on local streets	Procedure reports, mobile observations	Local
	Operations	Knowledge of local environment	Routine reports, mobile observations	Local
Police Department	Law Enforcement (Traffic Maint.)	Traffic conditions, roadway surface conditions, visibility	Mobile observations, individual reports	Control Hqts. (District or local)
	Incident Mgmt.	Incident type, location, and severity	Mobile observattons, CB monitor, individual reports, procedure reports	Control Hqts. (District or local)

Table 4. Data Sources Characteristics (Cont'd)

Source Group	Primary Responsibility	Data Collected	Collection Method Used	Consolidation Levels
Police Department (Cont .)	Accident Investig.	Hazardous locations	Mobile observations, procedure reports	State, District
Private Traffic Services	Providing information on traffic conditions	Incident location, type, duration, congestion locations, alternative routes	Fixed, mobile observations, CB & emerg. svc. monitor, Inquiry	Local Control Hqts.
Tourmg Services/ Auto Clubs	Point to point routing	Roadway characteristics, travel environment	Inquiry, mobile observations	National, local
		Detour and construction Info (type, location)	Inquiry, routine reports	National
	Services and accommodation info	Locations, quality	Inquiry, mobile observations procedure reports	National
	Road conditions, weather info	Surface conditions, visibility forecasts	Moblle observations, inquiry, indivldual report	National, local
Map, Atlas, Tour Guide Publishers	Route info, travel environment	Location, type of roads, major generators and and attractions, rest areas	Inquiry, routine report, mobile observations	National Hqts.
	Service info	Location, type, quality of services	Inquiry, mobile observations	National Hqts.
National Weather Service	Current and forecast weather reports; weather advisories, watches and warnings	Meteorological data	Electronic observations, fixed observations, procedure reports	Natlonal Hqts. State Forecast
Private Weather Services	Provide specialized weather info	Meteorological data	Fixed observations, inquiry, electronic observations	National Hqts.
Motorists	None	Traffic conditions, incident location and type, roadway conditions	Mobile observations	Receptor
Surveillance and Control Systems	Maxirnize flows on the controlled facility	Traffic volumes, occupancy incident locations, delay locations	Electronic observations, individual reports, procedure reports, mobile observations	Local

Table 4. Data Sources Characteristics (Cont'd)

Source Group	Primary Responsrbili ty	Data Collected	Collectron Method Used	Consolidation Levels
Special Roadway Authorities	Construction, operation, maintenance of special roadway (Bridge, toll road, .	Roadway characteristics, travel environment	Routine reports	Local
		Location of recurring congestion	Mobile observations, procedure reports	Local
		Current roadway and traffic conditrons	Mobile observations, fixed observations, electronic observations	Local
		Location, type, duration of Incidents	Mobile, fixed, electronic observations, procedure reports	Local
Transit Systems	Operation of Transit services	Locations of recurring delay, current traffic and roadway conditions, incident location and type	Mobile observations	Central dispatcher (local)
Volunteer Monitoring Group	Motorist and emergency ard	Locatron, type of incident traffic conditrons	Monitoring	Local
Chamber of Commerce	Promotion of local business and community	Services info, type, location, quahty, major generators and attractors non-services location info	Inquiry, routine and procedure reports	Local
Service Chains	Marketmg, (operation of particular services related business)	Location, type, quality operating info	Inquiry, routine and procedure reports	National or Regional
Individual Businesses	Operation of business	Location and services provided	Routine reports	Local

Automation of procedures varies from State to State. Generally, construction reports, maintenance schedules, and other cost- or project-related items are kept in a computer either at the district or at the central office through a terminal at the district. Other types of data which might be available concerning temporary roadway aspects are not formally recorded or kept in a computer file.

The State and local DOT's normally are not responsible for short-term incident management on the roadways, since this is a police task. They may be asked to assist, but not until the police or fire service find this necessary. They also have only limited radio communication capability, since not all vehicles are radio equipped, and the radio systems used are basic ones. The general exceptions to this concerns "managed" freeway sections where special surveillance and control is available (as discussed in a separate paragraph of this chapter).

There are normally good working relationships between the DOT's and police, since they work together frequently. Often, standard procedures are established which make incident management more efficient. For example, CALTRANS and the California State Police have established diversion routes around locations of recurring freeway incidents. CALTRANS truck-mounted variable message signs are used to guide motorists at locations along the route, and the decision to divert the traffic is made by the police with CALTRANS advice.

Local Traffic Departments

Almost every urban area has a local traffic department (called by a wide variety of names, including Traffic Engineering, Public Utilities, etc.) which is responsible for maintaining the street and traffic control system. Often this responsibility is shared in some manner with the State DOT. The local department will generally have minimal involvement with interstates and freeways even within the city limits since these are State-level facilities which receive State maintenance and attention. These local departments range from very large and sophisticated to ones containing only a supervisor and small field crew. They generally have a good knowledge of the local street system, but are not normally involved in incident management. They may know about weather-related conditions, depending on their responsibility for activities such as snow removal. They will know of locally-initiated detours and closings. Their records may be automated to some extent in the large areas, and even the smaller localities are becoming more oriented towards computer use for recordkeeping and other activities. They normally will have commercial radios in their vehicles, but the "fleet" is limited in the smaller urban areas.

State and Local Police

These public agencies are found in all States and many separate jurisdictions including urban areas, rural areas, and special areas such as national parks. They have general responsibility for law enforcement, motorist aid, management of incident situations, and accident investigation which all impact upon motorist information systems.

The police have two characteristics which make them important as data sources. They have:

- Manned units on the street throughout their area at all times of day.
- Radios to communicate information.

A normal police station receives not only transmissions from the patrol vehicles, but receives transmissions from other police agencies; monitors CB radio Channel 9; gets calls from motorists, citizens, and other public agencies concerning incidents; and receives routine reports from the DOT's concerning detours or other expected roadway conditions,

Automation has come to police stations in a variety of forms. Most stations have computer terminals which access the State or national crime network, division of motor vehicle records, and other similar data bases. They also may allow for printed communication with the central headquarters or State police. They may even allow for local recordkeeping and other administrative or management functions. Police radios in some urban areas provide a computer terminal in each patrol car which gives a visual display of messages, as well as allowing for data transmission between the car and dispatcher, or even directly with a State or national data base.

Concerning roadway incidents, the police have the primary responsibility for incident identification and management. Other agencies, such as the departments of transportation, are involved only when assistance is requested of them by the police. One police unit supervisor identified the priorities of the police concerning traffic incidents as follows:

1. Protection of life.
2. Protection of property.
3. Minimization of time delays to motorists.

These priorities are used when the police must decide the types of actions to take to correct an incident or whether to even respond if resources are limited.

Private Traffic Information Services

These for-profit groups operate in larger urban areas and provide reports on traffic conditions to local radio and television stations. They are currently found in the larger cities with heavy commuting volumes and are gradually expanding the number of their locations. Although perhaps on a somewhat larger scale and more sophisticated, their operations are reflective of radio stations in many small to medium urban areas throughout the country.

The services, including Metro Traffic Control (MTC) and the Shadow Network, use a variety of collection methods consolidated at a central location for broadcast preparation. Their primary interest is in incidents and delay locations, although they also report on roadway conditions or other factors which are influencing traffic. They normally presume a good knowledge by the listener of the local area and report using short, cryptic descriptions of the location and nature of problems and conditions.

They use the latest in technology to communicate and consolidate the data. The observers have mobile radios, sometimes hand-held units allowing for use outside a vehicle; and airborne observers are often available. They also monitor CB and emergency service channels, the U.S. Weather Service, and other secondary data sources. When available, reports from surveillance and control systems are also monitored. All this information is entered into computers which refine and reformat it as appropriate for the subscriber stations.

Touring Services/Auto Clubs

These for-profit or private not-for-profit groups have been gaining in popularity over the past several years. Although nationally based, they provide services on a local basis to subscribers, both urban and rural. The most well-known of these is the American Automobile Association, although there are many others, including ones operated by virtually every major oil company.

The data collected by these groups primarily involves the permanent roadway environment and motorist services. Some temporary conditions data may be available, but is normally obtained from secondary sources, such as the DOT's, and concerns detours and surface conditions, and not incidents or traffic.

These groups are generally quite automated with a computer data base which is accessed by the operators when preparing trip-related information for subscribers. Some of the data collection is done by their observers, but much of it relies on data supplied by motorist service providers and others because the national nature **of** the service prohibits more than a limited effort at primary collection. They generally have a good network of secondary data sources established and reformat the data from the various sources either manually or with computers.

Map/A&s/Tour Guide Publishers

These for-profit groups provide printed information primarily to meet static or semi-dynamic needs involving the permanent roadway environment and motorist services. Some of these publishers are related to the auto clubs, while others provide the guides as their primary service. They are available nationwide, providing information on both urban and rural areas. They generally focus on a region or State, but do provide information to the local level.

They generally do limited primary data collection. The data for the maps and guides are often provided by State agencies, motorist services operators, and others more directly associated with the data. Data are consolidated in a computer data base, and used to produce the printed information. Some actual observers may be used to verify information, but the efforts are limited.

National Weather Service

This public agency provides weather-related information in a variety of forms to users throughout the nation. Using a series of State forecast offices, they collect weather data and provide forecasts on a local, State, and national basis. The data is collected electronically and consolidated on large computers into forecasts. Some secondary sources, such as DOT's, are used to obtain roadway conditions, which are combined manually with the weather data to provide information concerning the roads and how they have and will be affected by the weather.

Private Weather Services

There are a small number of private, for-profit weather services in the country such as Weather Services International (WSI). These generally deal with the entire country, supplying weather, and other weather-related information to subscribers, such as radio and TV stations, trucking companies, or others who need it.

They do direct, primary weather data collection and forecasting using electronic means. They also use secondary sources such as the AAA for roadway condition information. The data are integrated together into comprehensive reports using computers. The information is disseminated via computer channels of various kinds to the different users.

Motorists

Other roadway users provide a potential source for information concerning roadway conditions of many kinds. Each driver observes incidents, surface conditions, and other environmental factors, as well as perhaps having a knowledge of the location of generators and other data. This data must be transmitted to a consolidation location to be useful. The only current methods are CB, amateur, and two-way commercial radios, all of which require a manual monitoring at some base-station location, and judgement concerning appropriate actions to take (verify, dispatch police, ignore, pass on to other motorists, etc.).

Surveillance & Control Systems

These publicly operated systems are found in larger urban areas where a particular roadway facility or group of facilities demands extensive attention to maintain needed vehicle flows. Because of their high cost of installation, maintenance, and operation, there are only a limited number in the country. They generally collect data using electronic means including sensors in the roadway and closed circuit TV as well as through reception of data from police, DOT's, motorists, and other sources. They sometimes have roving service patrols which also provide a data source.

The data is usually consolidated in a computer which assists the operators with analysis. Often visual map displays or other devices are also used to indicate status of equipment and perhaps problem locations.

Special Roadway Authorities (Bridge, Toll Road)

These agencies, which own and operate special roadway facilities at selected locations throughout the country, are often quasi-public (having been established under a special act of a governmental group). The nature of their operation provides them with a good knowledge of the facility, and they collect data as part of their daily operations. They often have mobile police or courtesy patrols, and maintenance crews, which report via radio to a central location. The toll stations are stationary, but the operators act as fixed observers to report data on weather, roadway conditions, etc. This data is normally only manually collected, consolidated, and processed, although like State and local DOT' s, the special authorities are incorporating computers into many of their current activities.

Transit Systems

Most urban, small urban, and even many rural areas throughout the country have a publicly operated transit system. This supplies vehicles and drivers to move persons throughout the particular service area. Many of these vehicles are radio equipped, and can communicate with a central dispatcher or office. The transit vehicle operators and street supervisors, like other motorists, observe traffic conditions, incidents, and other data on a daily, recurring basis. They also are normally scheduled to routes in major travel corridors throughout the area, and so provide a systematic or widespread view not obtainable through random motorist observations. Some systems currently provide this data to local radio stations, and most have procedures for relaying emergency information to appropriate authorities.

Transit systems are rapidly introducing automation for many of their activities. However, the monitoring of traffic conditions is not a major function, and is not even done routinely except in unusual cases. Therefore, little or no efforts have been made in this direction by the systems.

Votunteer Monitoring Groups

These private groups, primarily using volunteers, monitor CB and amateur radio channels to provide assistance to motorists or others in need. These groups, such as REACT, are found in selected urban and rural locations throughout the country. There are several nationwide systems for standardization of procedures, training, and support, but each local group operates autonomously. They do not collect any data directly, but by virtue of their operations they have knowledge of incidents, conditions, and other information of concern to motorists in their area.

Some of the groups are quite sophisticated, and have computers, retransmission capabilities, and other equipment. However, most use manual procedures for receipt and analysis of the data, and radio or telephones to contact police or request other appropriate assistance.

Chambers of Commerce

These groups are associations of private businesses in a geographic area, with the purpose of furthering the interests of their member businesses, and the local community. They are found throughout the country in urban, small urban, and some rural communities. They have an excellent knowledge of the businesses, major generators and attractions in their areas, which may include motorist services. Their activities are not heavily automated, but often printed summaries and other materials are prepared. Some areas have public or quasi-public organizations known by names such as tourism **or** travel councils which are similar to chambers of commerce. Their responsibility is to promote tourism, and thus provide useful motorist information.

Chains

These private groups represent service facilities under a common name throughout the country. They generally are of the nature of gas, food, lodging, or camping. They collect and publish detailed information concerning their operations, normally organized on a geographic basis. They may also provide telephone information or reservations on a national basis. Their efforts are largely automated, with extensive computer capabilities for data input and retrieval. Each company provides data only on its own operations, and prepared formats vary somewhat.

Individual Businesses

Individual private businesses may be involved with motorists if they provide a service or operate a major generator or attraction. These businesses, which are found in **every** type of area throughout the country, can provide detailed data concerning their own operations. For major generators, the owner-operator may be the only comprehensive source of current data on temporary conditions such as parking availability. Because the owner has an interest in attracting customers, the data provided may not be completely factual. Individual businesses vary from extensive computer capability or administrative capacity to none at all.

Summary

In contrast to the limited number of data collection methods, there are a large number of groups which collect data needed for motorist information. Many of these groups collect the data to transmit it to motorists, while others have it available as part of their regular operational activities but do not make use of it for motorist information. For the former group, the challenge is to improve the effectiveness of their operations to allow them to provide information in more detail, in greater quantity, to a larger audience, more timely, or at less expense. For the latter group, the data must be accessed in some manner so it can be included in the base of data to be transmitted to the motorist.

A low-cost system can seemingly best be structured by using data which is already being collected as part of on-going activities. In the case of the police at all levels, and perhaps other groups, the barrier is a means of their providing the data on roadway incidents and conditions without interfering significantly with their other activities. Only by providing for an “easy-effort” process will the data be obtainable. Some of the electronic procedures and communication links used by the private traffic services, auto clubs, and others currently providing data, may be appropriate to apply in other situations.

Also, the initial consolidation of data as it comes from the source is valuable. Through an initial consolidation, extraneous, redundant, or incorrect data can be filtered out, so that the data which reaches the primary consolidation center requires a minimum of verification and processing. Several of the collector groups conduct this initial consolidation, and improving their procedures would be valuable.

Data Transmittal Methods

After the data has been collected and perhaps undergone an initial consolidation, it must be transmitted to the primary consolidation center. This process is a key one and the transmittal method must have several characteristics:

- It must be **appropriate** to the type of data being transmitted. Timely or perishable data must be transmitted quickly, while more static data can use slower transmittal methods. The amount of data to be transmitted will also affect the method used.

- It must be **readily available** to the data collector or transmitter. The transmittal method should be a part of the day-to-day operation of the data source, so that the marginal cost of preparing and sending the motorist-related data is low. Also, time on the communication link needs to be available for use by the sender.

- It must be **receivable** at the appropriate receiving consolidation center. The center needs to have receiving equipment and procedures coordinated with the source to allow for completion of the transmission.

If all of these characteristics are found, a communication system is in place between the data source and consolidation center which can be used to transmit the data message.

There are a relatively limited number of methods currently used to transmit motorist-related data between sources and consolidation centers. These include:

- Written.

- Radio (two-way commercial and CB).

- Telephone.

- Teletypewriter.

- Computer terminal with modem.

- Personal contact.

Each of these has benefits and costs and is appropriate for certain conditions. They are discussed in a narrative form below, and more technical characteristics summarizes in a table at the end of this section.

Written communication can include data transmitted by letters, forms, or other printed matter, using mail services. This normally takes from one to four days to reach the consolidation center, and so is only applicable for less time-sensitive information concerning semi-dynamic or static needs. The cost of transmittal is low, but there is a cost in the time required to prepare any special formats or letters. Large amounts of data can be transmitted, but these must then be manually extracted and refined at the consolidation center. Standard formats can be prescribed for the written data to help this process. Courier services can speed delivery between local locations but increase the cost considerably (about $10 per delivery).

Radio provides excellent instantaneous two-way communication and is the most flexible in terms of location of the source. The source sending unit is relatively inexpensive, but a monitoring unit and operator, and frequently a larger, more expensive base station is needed at the reception side. Because of the constraint to only verbal communication, only limited amounts of data can be transmitted, so the method is best suited for dynamic information needs.

The **two-way commercial and amateur radio** has a relatively long range and can be used in both urban or rural settings. The equipment is more expensive than CB to purchase and maintain. The commercial radio requires a license for use, and the amateur operator must be licensed.

Amateur radio clubs in the 2-m band (144-148 MHz) have established repeater sites with the capacity for direct interconnect into the public telephone system, which provides an almost unlimited extension of range. However, the number of these units is relatively small.

CB radios have only a 5 mi (8 km) range, which can be extended through the use of remote retransmission devices. However, it is interruptable by others on the channels, and so is less reliable and allows for even less data to be easily transmitted than the commercial radio. The relatively low price makes CD radios attactive to many motorists and other potential users.

Telephones are a transmittal method with many benefits. They offer uninterrupted conversation, and for local calls the marginal cost of use is very low. However, they again can transmit relatively limited amounts of data due to their verbal nature. For reception a telephone conversation can be relatively easily taped and automatic answering devices used to eliminate the need for an operator at the consolidation center. Leased line can guarantee ready access between two points.

Fixed telephone units are found in most urban and rural settings throughout the country. Installation of new units is becoming somewhat more costly, but normal use and maintenance is relatively low cost.

Mobile (radio) telephones are now entering the communications market in most large- and medium-sized cities in the U.S. These units will provide to the data source the ability to have telephone contact while in a vehicle or even outside the vehicle using more mobile units being developed. The cost of installation of these units is high (over $1,500), and their per-call charge is higher than fixed unit so that it would be desirable to transmit data as succinctly as possible. However, the improved mobility and access to the telephone system virtually worldwide from an urban location is valuable.

Teletypewriters are older, electromechanical devices which allow for data to be entered on a keyboard at a source location and automatically printed on similar equipment at one or many other reception locations. The equipment is relatively expensive to purchase, but operation and maintenance are generally low. Commerical systems may be subscribed to, which supply the unit and dedicated lines. However, an operator must key in the pertinent data. It is rapidly being replaced by the computer terminal but does offer opportunities to transmit any type of data rapidly.

Computer terminals with modems offer major advantages in data transmission. If the data is stored on a disc or other access device, large amounts of data can be transmitted quickly and accurately. It can be received at the consolidation center automatically, and entered directly into their data base for processing. The equipment, which requires a terminal (input device), a modem and telephone line or other communication link, and a receiving terminal or device is relatively expensive to initially purchase and then to maintain. However, the computer can be used for many other purposes than the transmittal of data. Its versatility makes it ideal for transmitting all types of information from dynamic to static. Development is underway to allow terminals to be used over cellular telephone connections, providing even greater locational flexibility.

Electronic sensors and closed circuit TV are transmittal devices which have very limited applicability. They are both collection devices and transmittal links, since being electronic, the data travels automatically to the receiving center. These devices are expensive to install and maintain, but they provide data on real-time conditions at remote sites, without the need for an observer on the scene. Sensors often need a computer to analyze their input and verify their information, while the CCTV must be viewed by an operator for interpretation. Because of'the complexity of their installation, and the system needed to receive and respond to their data, they are only used for very time-sensitive data at critical locations in urban areas.

Personal contact is the most basic form of data transmittal and consists of one person telling another directly concerning certain conditions. It requires the two persons to be in physical proximity, which can require travel, and will take time. Also, only limited amounts of information can be transmitted, although this information can be refined and discussed on-the-spot. It would be appropriate for any type of data, but especially data that might be complex or confusing since the transmitting person can ensure understanding by the receiver through further conversation.

Table 5 summarizes some of the technical characteristics of the identified data transmittal methods. The characteristics used and the rating scheme are discussed in some detail below.

Preparation/Input Requirements is the amount of preparation needed before the data can be transmitted. This would include both formating and writing or "keying in" the data. The following ratings were used:

High indicates the data must all be written or keyed in before transmittal.

Low means some preparation such as mental or informal organization must be done.

Table 5. Data Transmittal Methods

Characteristic	Written	2-way commercial and Amateur Radio	CB Radio	Fixed Telephone	Mobile Phone	Teletypewriter	Computer Terminal	Electronic Sensors CCTV	Personal Contact
Preparation/Input Requirements	High	LOW	LOW	Low	Low	High	High	None	Low
Items (Cost) of eqmt. or hardware	None (Low)	Transmitter (Moderate)	Transmitter (Low)	Telephone (Low)	Mobile Phone (High)	Tty. and Link (Moderate)	Computer, Modern or Link (Moderate)	Sensorsm, CCTV, Link (Very high)	None (Varies)
Tune of Transmission	1-4 davs	Instant.	Instant.	Instant.	Instant.	Instant.	Instant	Instant.	Variable
Distribution of data per action	Wide	Very limited	Very limited	Limited	Very limited	Wide	Wide	Very limited	Very limited
Amount of data easily trans.	Large	Small	Small	Small	Very small	Ldrge	Very large	Small	Small
General geographic availability	All locations	All	All, but limited range	All locations	Urban	All locations	All locations	Urban	All locations
Reception/buffering requirements	Files Log or recorder	Log or recorder	Log or recorder	Log or recorder	Log or recorder	Tty.	Printer or storage device	Computer for sensors, display video recorder for CCTV	Log
Types of data applications	Semi-dynamic, static	Dynamic	Dynamic	Dynamic, semi-dynamic	Dynamic	All	All	Dynamic	All

None means the preparation is done automatically during the collection process.

Item Cost of equipment or hardware needed identifies the main equipment needed to make the transmission, and the cost level (in parenthesis) of this equipments purchase.

Very high cost means over $10,000.

High cost is $1,000 to $10,000.

Moderate cost is $250 to $1,000.

Low cost is under $250.

Time of Transmission is the period between sending of the data from the source to receipt by the consolidation center. For all electronic means this is basically instantaneous. Mail takes at least one day (couriers take several hours). Personal contact varies depending on the travel time between the source and receiver.

Distribution of Data Per Action is an indication of how many different consolidation centers or receiving limits can be reached with a single transmission by the data source.

Wide indicates that a large number of centers can be reached.

Limited means only a few, or ones with a limited range, can be reached.

Very limited indicates only one center at a time can receive the data.

Amount of Data Easily Transmitted characterizes the volume and/or complexity of data which can be transmitted via the media.

Very large means a virtually unlimited amount of data.

Large means thousands of pieces of data.

Small indicates the amount of data is limited to verbal means, perhaps 50 pieces or less.

Very small means a limited time is available, perhaps 10 pieces of data.

General geographic availability judges whether the method is available in urban, rural, or all locations in the country.

Receiving/Buffering Requirements indicates the equipment and/or procedures needed to receive and then save and store the data received from the source. These include:

Files, for storing in written form

Log or recorder, meaning a written log by an operator or a voice recorder used to record the transmission.

Printer or storage device receives computer data, and produces either a “hard copy,” or automatically stores the data on magnetic tape, floppy disc, or other device.

Teletypewriter indicates that a teletypewriter is needed at the receiving end, and it contains its own printer to produce a “hard copy.”

Types of Data Application indicates the best or optimal use of the method, based on the overall characteristics of the method.

Findings Concerning Data Collection

The investigation of data collection procedures has produced an improved understanding of who is collecting data of various types, and how they are doing it. From this investigation a number of findings were made which are described below for dynamic, semi-dynamic, and static information. A general finding, which can be applied to all types of data, if there is not a universally "best" method of collection, source of data, or method of data transmittal. Each consolidation center must evaluate its requirements and select the most effective, appropriate methods available to it.

Dynamic Information

Data concerning dynamic conditions is the most difficult to collect due to its rapid rate of change, and the fact that it exists only as a condition on the roadway (as opposed to being available in records or other forms). Incidents are also relatively unpredictable as to occurrence, so surveillance or observation on a continuing basis is necessary to identify them as soon after their occurrence as possible.

The problems of collection in rural areas is especially severe, since there is a larger geographic area of interest and fewer potential sources of data. The resources available to collect data tend to be focused on the urban areas because of the larger potential user group (i.e., more autos on the roadway). The lower rate of incidents on rural sections of major roadways somewhat lessens the requirements. However, weather-related roadway conditions, and major changes in the roadway condition (detours, bridge closings) are important needs which must be identified, even in the rural areas, so that effective efforts can be made.

There is a finite number of ways to collect data, and only a few of these are useful for dynamic information. Generally, for changeable data such as detection of incidents or temporary roadway conditions direct observation is needed. However, this is costly because it is labor intensive.

Electronic observation using sensors is a valuable alternative for collection of dynamic data. However, the data on incidents must be confirmed or verified using CCTV or other methods. Also, this method is very expensive in terms of capital cost since it requires hardware and communication links to a central observation or control center. Consequently, it has only limited applicability, primarily in larger urban areas.

Monitoring of communications from roadway users, and receiving phone calls and reports from groups concerned with the roadway conditions provide a supplement to direct observation or surveillance. This can be monitoring of CB radios or emergency services.

It appears that dynamic data concerning an area must be obtained through a combination of several sources. Not only must incidents, delays, and other problems be initially identified, but their impacts on traffic must be monitored on a continuing basis. This requires coverage over the geographic area, and an ability to observe or obtain data over what could be an extended period of time. No single source provides for both of these characteristics.

To keep a system low-cost, it will probably be necessary to find ways to obtain data which is being collected by groups as part of their on-going activities. This would mean a relatively low marginal-cost formatting the data, and transmitting it to a consolidation center. Establishing new data collection systems would be more costly and institutionally difficult than tapping existing sources.

Since dynamic information exists in the field, groups whose reponsibilities or activities require them to be on or near the roadways will be the most useful. These include:

- Police (State and local) - who patrol roadways and respond to incidents.
- DOT's (State and local) - responsible for snow removal, and roadway maintenance.
- Transit Systems - buses travel throughout the area, with professional operators.
- Motorists - Auto and truck drivers are on the roadways, observing conditions.

The key to using these groups is the availability of a communications method and the capability of the field unit or person on the road to transmit the data to a consolidation center. The latter requires capability in terms of observations, uniformity of observations, descriptions, and use of the communications medium. Police, for example, could be expected to have a high availability of communications medium and observation capabilities. Drivers of radio equipped delivery trucks would have communications capability, but would require training to enhance their observation capabilities.

For general motorists, CB's and amateur radios can be used. However, organization of their efforts in some way to ensure comprehensive coverage is necessary.

The Private Traffic Services have been effective at this organization. The Shadow Network uses selected commuters in key corridors to provide data via two-way radios. They also query truckers using remote CB's in major corridors, when they feel they need more details or to verify a suspected incident. However, both of these sources are supplementary to the base data obtained using aircraft and mobile staff observers.

The availability of mobile telephones may provide additional opportunities for data transmittal. Observers engaged in other activities, even commuting, could report on dynamic conditions, and a recording device could be used to receive the information if necessary. This system would have a much longer range and overcome many of the problems of the CB radio. It may soon be possible to use a computer terminal from the vehicle, which would allow entry of data directly into another computer at the consolidation center.

In rural areas, the same level of awareness of dynamic conditions is very difficult to obtain in a cost-effective manner. The two primary sources here appear to be:

- State police (and local police to a lesser extent).
- Truckers and other frequent drivers who are on the interstates in the rural areas.

The problem again is to organize the effort, and get the data to a consolidation center. A definition of the high priority data actually needed would be a necessary step.

Rural areas, as well as urban, are relatively well covered for weather data because of the extensive network of National Weather Service stations. The concern here is how to provide information on severe weather (and incidents as well) to the unfamiliar motorist, which is a transmittal problem to be addressed later in this study.

In summary, the methods and data sources for effective collection of dynamic data, particularly in urban areas, appears to exist. The challenge is to organize and coordinate the efforts and provide a means for the data to be effectively transmitted to the consolidation center.

Semidynamic Information

This type of data relates primarily to the longer distance traveller and the unfamiliar motorist. The exception is long-term detour and construction locations which are a concern to all motorists. Semidynamic information tends to be more detailed and larger in volume. It often has two levels, the primary one which concerns the basic location and type of the motorist service, and the secondary one which involves details on characteristics (i.e., cost, credit card use, etc). The semidynamic needs do not require the emphasis on timeliness of the dynamic one and so lend themselves to different procedures in all the major aspects.

Because this data does not change rapidly, the emphasis is on collecting the data across extensive geographic areas and handling the large volume of data. The data also must be updated periodically after it has been initially identified and obtained.

This emphasis points to inquiry and reception as the most cost-effective means. Direct observation is required to a limited extent, to initially identify a service or location, and to later verify data provided. However, since there is a greater volume of information and the changes may be relatively slight, an ability to easily generate requests for data **or** verification forms for already identified data is required. This points toward a computer-based system which prepares questionnaires to be mailed to the services or generators involved, and allows for easy updating of the data base.

The data to meet semidynamic needs, such as parking availability or details on motorists services, is often available only from the operators. Therefore, any effective data collection must reach these persons or organizations directly, or be initiated by them. There is normally a profit-motive in getting this data to the motorists, from the viewpoint of the operator of the service or attraction. If a communication line is established between them and the consolidation center, whether it is written or oral, they can be expected to respond to requests for data.

As with dynamic data, the collecting of semidynamic data in rural areas is somewhat more difficult than in urban settings due to the geographic expense. However, the existence of national service chains and the desire of attractions and generators in rural areas to advertise, makes this type of data much easier to obtain. The longer-term roadway data is kept routinely by the DOT’s, and can be accessed from them. Their efforts with general service and logo-service signing have also provided them procedures for identifying and contracting appropriate service-related businesses.

Static Information

Static information changes relatively infrequently and primarily concerns physical aspects of the roadway. This data is often in central locations such as the State DOT in the form of records. Thus, its availability is good with some exceptions. Data on telephones which are not directly on the roadway and on contacting emergency services is not readily available since it is not collected by the DOT's.

Since much of the data is in records, inquiry is the primary collection method. Observation may be needed occasionally to check on data for non-roadway characteristics and to verify data.

Because of their responsibilities, groups which operate roadways of various types will be the key collectors. These include DOT’s, special roadway authorities, and occasionally surveillance and control systems. Recent signing changes for the interstates have brought the DOT’s a greater awareness concerning the locations of telephones and medical services, while the toll roads have traditionally had good signing for services. Chambers of Commerce and business groups may also be valuable collectors.

Much of the static data will have been collected when the roadway was constructed and signs initially set. Only for data which is not currently well portrayed on signs will any data collection really need to take place. Here, the issue may be how to best present the data (such as off-road telephone locations) without overly cluttering the visual environment.

CONSOLIDATION CENTERS

Consolidation centers perform an important processing step linking the data collection (input) with the information transmittal (output). The purposes of this section are to examine existing consolidation center functions, to develop some basic functional requirements for consolidation centers, and to outline the required processes for handling various types of information. This will provide input to defining alternative future consolidation center concepts in Chapter 4. Because of the differences in how the three different types of information (dynamic, semidynamic and static) are handled, the discussion of consolidation center concepts and requirements are oriented around these three information types.

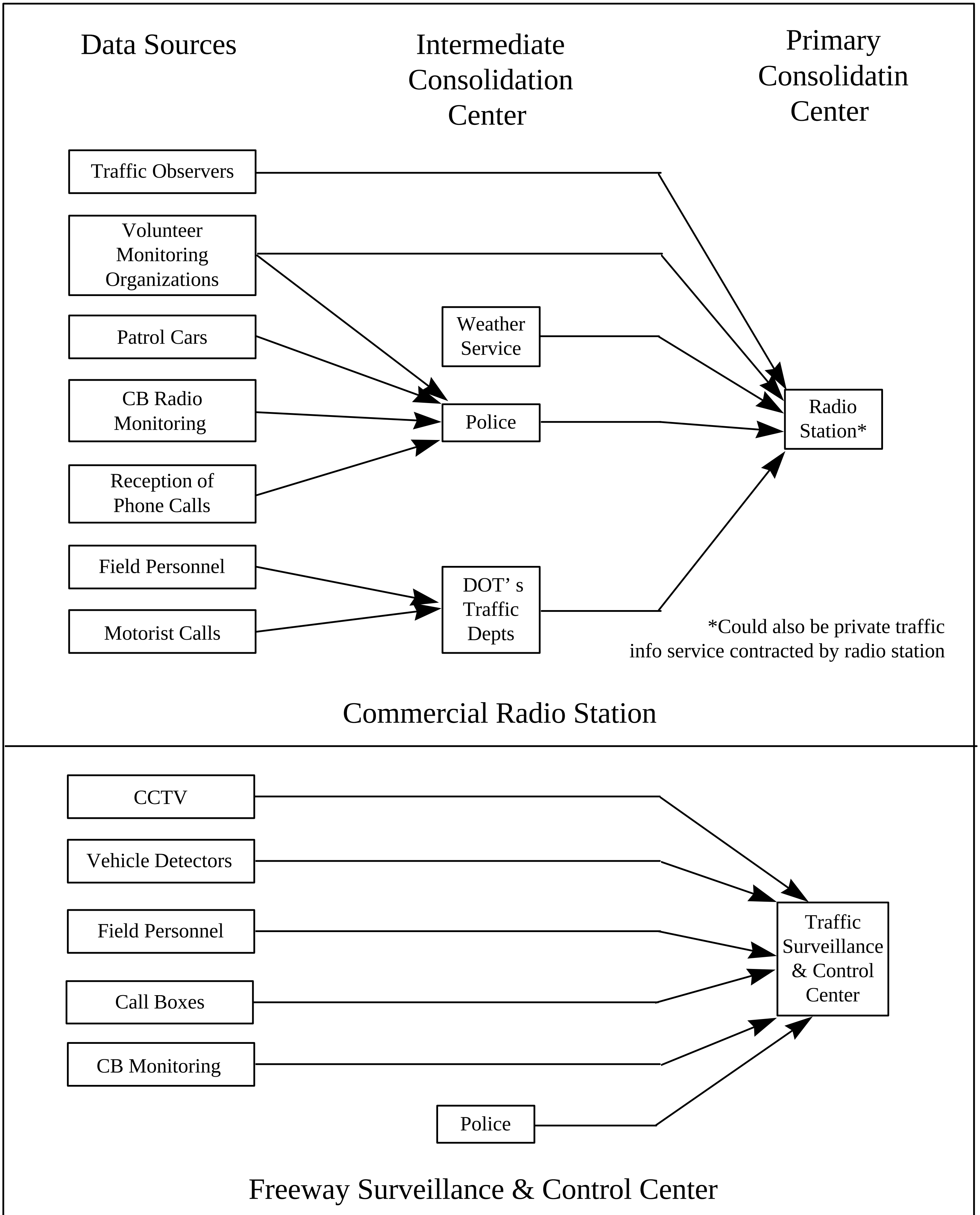
Overview of Existing Consolidation Center Structures

Figure 2 diagrams the structure of some of the existing consolidation center activities for dynamic information. The figure recognizes that information consolidation is often a multistage process and that the data sources do not always have direct input to the primary consolidation center. The final consolidation center is defined as the last point at which information is consolidated before it is transmitted. There may well be intermediate consolidation centers which perform a preliminary screening of information, relieving the final consolidation center of much of the burden of screening out irrelevant, repetitive or less important data.

The best example of a multistage consolidation process perhaps is a commercial radio station or private traffic information service acting as the primary consolidation point. Although radio stations are often thought of as transmittal media, one of their primary functions is the consolidation of information which will go on the air. For traffic information, the radio stations rely on a variety of sources including police departments, local transportation departments, volunteer CB radio monitoring groups, and weather services for data **on** current traffic situations as well as their own aerial or ground-based traffic observers. In larger urban areas these activities are often done through or in conjunction with a private traffic information service. Probably the bulk of the data consolidation takes place at the intermediate stages, but the radio station puts all the various inputs together, and controls the priorities with which that information gets out to the public. There are, of course, many variations of this structure in different metropolitan areas, but this represents a typical scenario. Often, live reports are given by certain aerial or ground-based observers. In this case, the observers themselves essentially become the consolidation operation, receiving information from other sources, screening it, and putting the higher priority information into the traffic report.

Traffic data, such as that obtained through telephone calls to police or highway departments, police or CD radio monitoring, and information from aerial and ground-based observers is recorded either in written notes or on computer. Information sent in a prepared format, such as reports on recurring detours due to construction are kept available, and delays due to these locations are planned for monitoring by observers. Sometimes a map is used to manually keep track of problem locations.

Since private traffic groups often provide information to several different radio and/or TV stations, they use computer-based consolidation. The information received from various sources is manually entered in a computer. This allows for easy updating to ensure the latest data is available. Condition symbols for graphic displays and other refinements of the data are coded in by an operator. Generally, subscribing stations receive the consolidated information in one of three ways: 1) electronically transmitted hard copy reports, 2) live audio feeds, 3) recorded audio feeds. Stations in the Chicago area can purchase access to the graphic displays and other computerized information which is generated by the surveillance and control systems in the area.



Consolidation Center Structures for Dynamic Information

Figure 2

One observation is that dynamic information, to be compiled in a timely fashion, requires the data consolidation to be spread among more people and agencies. It also requires more breadth in the number and type of data sources. Some agencies have tended to have better access to certain data sources than other agencies, due to the nature of their business. For example, the police departments, having the responsibility **for** traffic maintenance and enforcement, are the first to know about many of the traffic incidents, especially those involving an emergency. It would appear that any information consolidation structure will have to take advantage of these natural agency functions, to the extent possible.

A generic consolidation structure for meeting semidynamic information needs is shown in Figure 3. The structure for semidynamic information generally does not include intermediate consolidation centers to the same extent as the structures for dynamic information. A variety of information providers, including auto clubs, travel agencies, tourist councils and other groups, could serve as the primary consolidation point. Often, there is direct contact with the individual establishments which supply the data. However, this distinction is not always clear-cut. For example, hotel chains compile their own information on locations, prices, and other information, and in that sense comprise intermediate information consolidation points. They even serve as primary consolidation points to a certain degree, as they provide brochures, maps, and other data regarding their operation. Figure 3 does not adequately represent the entire range of consolidation center concepts for semidynamic information needs, and it would be difficult to do so because of the great diversity of structures in this category.

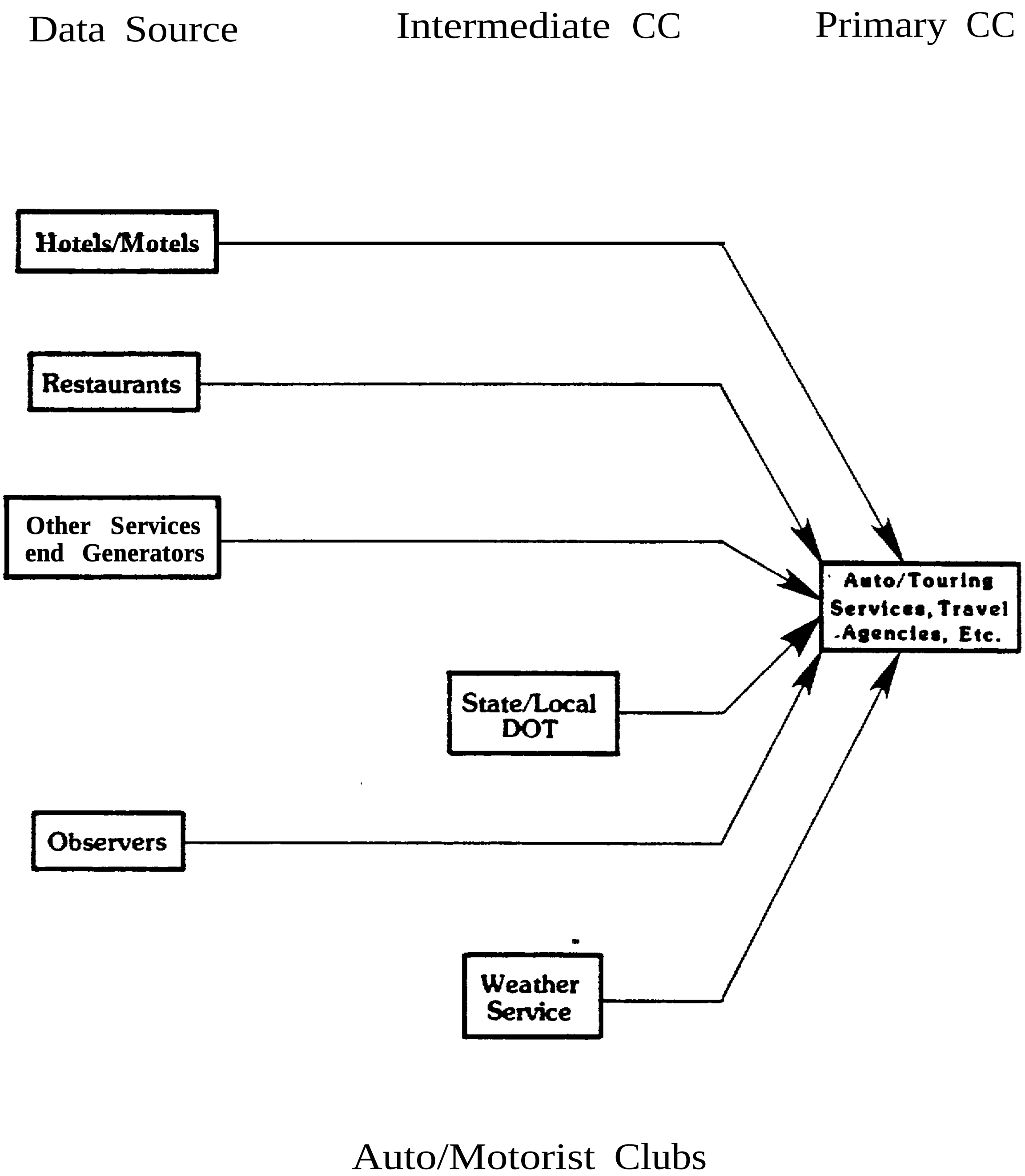
The trend in the reception and storage of this type of data is toward computer-based procedures. For yellow pages and other directions, requests for updates on information are generated automatically by the computer, and billing is merged with other telephone bills of the customer. The data is then entered from a returned form into the computer for generation of appropriate listings.

Existing structures for consolidating static information, are shown in Figure 4. These revolve primarily around the transportation departments at both the State and local level, which typically have responsibility for roadway signing. Political bodies and citizen groups can also be involved in this process as intermediate or primary consolidation points, depending on the local governmental structure. The process is quite different from consolidation processes for dynamic and semi-dynamic information, usually involving a more lengthy period of political and engineering review and approval.

Consolidation Center Functional Requirements

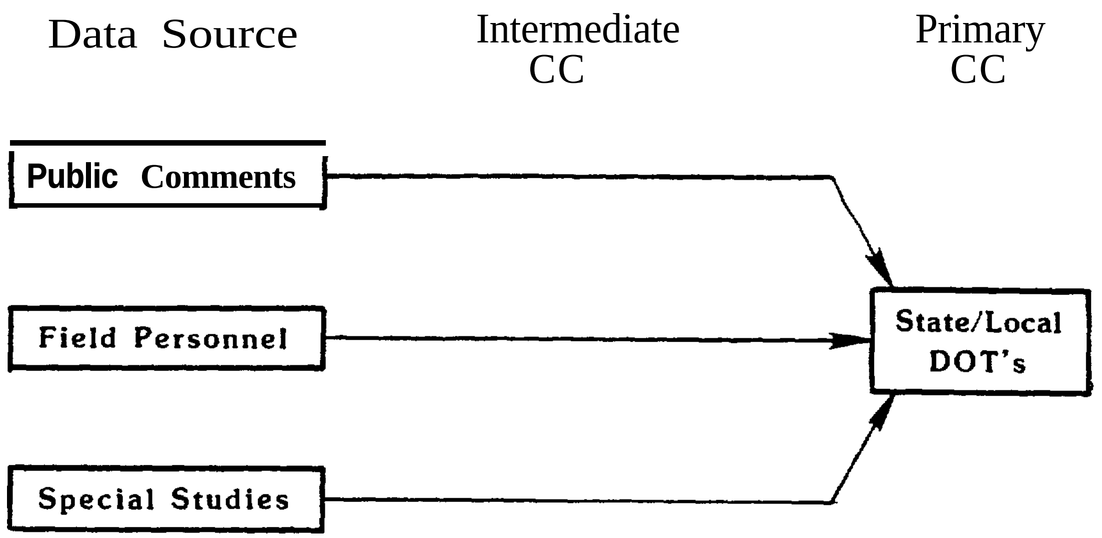
Consolidation centers can take on many forms, depending on the type of motorist information being dealt with, but they would all typically involve the following activities:

- Data reception.
- Buffering.



Consolidation Center Structures for Semidynamic Information

Figure 3



Consolidation Center Structure for Static Information

Figure 4

- Data validation.
- Data analysis and refinement.
- Output preparation.

A brief discussion will provide a background for understanding how each of these is incorporated into centers handling each of the types of information.

Data Reception is the receipt at the consolidation center of the data from the sources. This is closely tied to the data transmittal modes discussed earlier, since the center must be capable of receiving the data in the form in which it is transmitted by the data source. The receipt can involve a person, through answering a telephone **or** radio, electronic receipt, as with a computer terminal, or administrative process as with a box or slot for letters.

Buffering of the data stems from the computer analogy, in which a holding area is provided for data that cannot be immediately processed. The consolidation center must have the capacity to receive information and store it until it can be processed. This buffering can range from a tape recorder for voice messages, to a computer disc for digital information, to a file drawer for letters and memos.

An alternative to the reception and buffering of data is to access it only upon demand from the consolidation center. In this case, a buffer would not be needed on the consolidation center side, but there would perhaps be a need for an accessible buffer or storage on the source side. A computer data base concerning weather **or** roadway information which could be accessed by a radio station preparing a report would be an example of this arrangement.

Data Validation is the screening or testing of data to determine its accuracy and validity. One of the primary problems encountered in processing dynamic information is the difficulty of validating information in a timely fashion. The failure to adequately validate data quickly destroys the credibility of the information, as erroneous information will frequently filter through. A great deal of data can arrive at a consolidation center and it must be checked and analyzed to filter out unwanted or obviously incorrect elements. Then, items that need further details **or** which may have errors must be checked. This checking can be a comparison against other sources for uniformity or the dispatch of an observer to verify the information.

Data Analysis and Refinement is the process of taking the data and turning it into information useful to the motorist. This may include a complex procedure of analysis using a variety of data elements combined to form a conclusion, as in preparing **a** map or graphic representation of a roadway system. It could also be as simple as using rules of thumb concerning queues resulting from incidents in a certain section of roadway. It may also include changing the format of the data to organize it appropriately for the final step. Checking information concerning a service facility against that previously submitted and identifying changes would be an example of this.

Preparing for Transmission is the final step. Here the refined data (information) is put in final form and input into the transmittal system. In some cases this will include selection of the appropriate transmittal method, if more than one is available. Services data may be sent off to be printed, a message selected for a variable message sign, or a radio report recorded for transmission.

Each of these steps is conducted somewhat differently, depending on whether the information is time sensitive or not. The following section discusses the different approaches used. This will set the scene for the more detailed discussion of procedures which follows.

Functions for Handling Dynamic Information

Data Reception - Because of diversity of data sources and the stringent time constraints under which dynamic needs must be met, the data reception capabilities of dynamically oriented data consolidation centers are quite demanding. Because the data assembly has to take place in a relatively short period of time, it is also sometimes most efficient to employ intermediate consolidation centers to act as a screening point prior to the reception of data by the primary consolidation center.

Examples of the data source/consolidation center interface were previously illustrated in Figure 2. As mentioned, the classic example is that of a typical AM commercial radio station which maintains a high degree of emphasis on reporting traffic conditions in the peak periods. Telephone connections are normally used for receiving police and highway department data, teletype and telephone may be used to receive weather information, and radio may be used for the others. The police usually serve as intermediate consolidation centers, receiving data from officers in the field from motorists calling in accidents or, in some cases, from the monitoring of CB radio communications. Information is screened at this initial stage, and only those items of potential interest to the radio stations are passed on.

Another example of how data reception may operate is with a traffic control center in a major metropolitan area. Here, information may be received from all of the above sources plus from the often significant capabilities of the control system itself (volume, occupancy, and speed data from detectors, as well as visually through CCTV and/or call boxes if available) using both computer and manual reception.

Functional requirements for consolidation center dynamic data reception capabilities relate primary to the access the center must have to the data sources. The connection with the source must be direct and involve minimal lag time between the actual occurrence of an event and its reporting to the final or intermediate consolidation center.

Buffering - The buffering capability is most critical in the case of dynamic information needs, as the frequency with which data enters the system is high and the other consolidation center functions are not always immediately ready to act on the information. The buffer must be large enough to handle the quantities of information likely to be accumulated prior to its being processed.

Data Validation - Data validation is necessary to the degree that the source of the data is trusted. Where information has already been through an intermediate consolidation point, much of the erroneous data will have already been screened out. Typically, on-going arrangements are made between agencies or departments to acquire information, and the receiving agency finds out relatively quickly whether a source can be trusted or not.

A prime example of the need for data validation of incoming dynamic information is with the monitoring of CB radio transmissions. Because of the lack of specific training in what is and is not important emergency information or in how to give directions, motorists reporting through CB radio are more susceptible to providing inaccurate information. Validation techniques include verifying the information through transmissions from other motorists, or with on-site observation by trained agency representatives.

Functionally, the validation process should have a high probability of screening out false information but at the same time should result in little chance of significantly delaying a validation of correct information. In other words, the validation process must be both rapid and accurate.

Data Analysis and Refinement - Following the validation of the information, an analysis of the information must be performed from several perspectives. Several of the questions which must be asked are as follows:

- How important is the information in relation to other data?
- To what user group does the information apply?
- How quickly is the information to be transmitted?

The refinement of data refers to adding, deleting or modifying the information to make it more usable. The modifications would be based on other information also received. In the case of dynamic information, this must again take place quickly to maintain the currency of the information. Also at this stage, criteria on message clarity and brevity need to be applied.

Output Preparation - The preparation of output will vary depending on the media for which it is prepared. In most cases, textual messages are required for either sending to the final transmission medium or for direct broadcast to motorists. For dynamic information, preparation timeliness is a critical factor, and certain techniques can be used to decrease time while also facilitating clear, brief messages. For example, a traffic control system could be made to develop its own traffic reports for certain conditions by having a standard message structure with the variable components inserted directly from system detector data and/or messages already generated from other activities of system operation. Usually, these messages would need to be checked before they went out, but they could improve the currency of the information and relieve operating personnel of the time required to compose completely new messages.

Another technique with application to highway advisory radio or changeable message signs is to have a precomposed set of messages available to respond to a variety of conditions. Once the condition is met, an operator or, in some cases, the system itself would be able to select the corresponding message to transmit or display until the condition changed. This is commonly done in some automated traffic control systems in urban areas.

Functions for Handling Semidynamic Information

Data Reception - A system to manage semidynamic information involves a somewhat different structure than a system to manage dynamic information. Semi-dynamic information, such as vehicle services, restaurant information or special events information, tends to change much less frequently than dynamic information and, of course, has a completely different set of data sources. Consequently, data reception needs are substantially different also.

For example, an unfamiliar motorist on a freeway may desire information on restaurant **or** hotel accommodations. The information desired often includes location, name, cost, and other details of the facilities. Although this information does not change frequently, when it does change it must be reflected quickly in the transmittal media.

A consolidation center oriented around semidynamic information could range from the telephone company compiling listings in the yellow pages to a commercial service compiling a data bank with more detailed information on services and facilities, accessed by a computer terminal. For semidynamic information, the consolidation center usually depends on the data source to keep the information current. The telephone company relies on a restaurant to report any changes in yellow page advertising, for example. On the other hand, an information center may seek out and compile the various types of information it desires to relay to the public.

One important aspect here is that a standardized reporting format is essential for incoming information. This ensures completeness of the data, and compatability of the information with processing and output formats.

Buffering - There is relatively low requirement for buffering in a semidynamic information consolidation structure, compared to the needs in a dynamic setting. The reason is that there is somewhat less information to be compiled within a given time frame and it can often be handled immediately after it comes in. For example, changes in address may be directly handled over a phone and entered into a computer data bank. On the other hand, written requests for changes in advertising or displays or brochures may sit in an in-basket for hours or days before they are processed without overly negative results.

Data Validation, Analysis, and Refinement - Because there is usually direct reliance on the data source for a semidynamic information framework, there is also relatively less need for data validation. The source would generally need to be taken at its word. Some validation could take place through comparisons with information from related sources, previous information, or spot-check observations.

Output Preparation - Output preparation is perhaps the major task of consolidation centers within a semidynamic information structure. Many of these centers are in the business of preparing directories, brochures, maps, and other materials for distribution to or access by the users. Functional requirements for the preparation of this information include clarity, comprehensiveness, standardized format, and accuracy of the information.

Functions for Handling Static Information

The reception, buffering, validation, and analysis functions for meeting static information needs are somewhat similar to those required for the semidynamic structure, but usually even less time-critical in nature. Static signing comprises the major transmittal method of this type of information, and highway departments serve as the consolidation center in most instances. The process may be more politically oriented and the information flow would be comprised of primarily written letters and nemos with special studies serving in some cases as background information upon which decisions may be based.

Consolidation Center Procedures

This section discusses typical consolidation center procedures for the three basic types of information needs. The flow of information **is** traced from reception to output preparation, and an analysis is made of the efficiency with which the consolidation process takes place, using selected case studies.

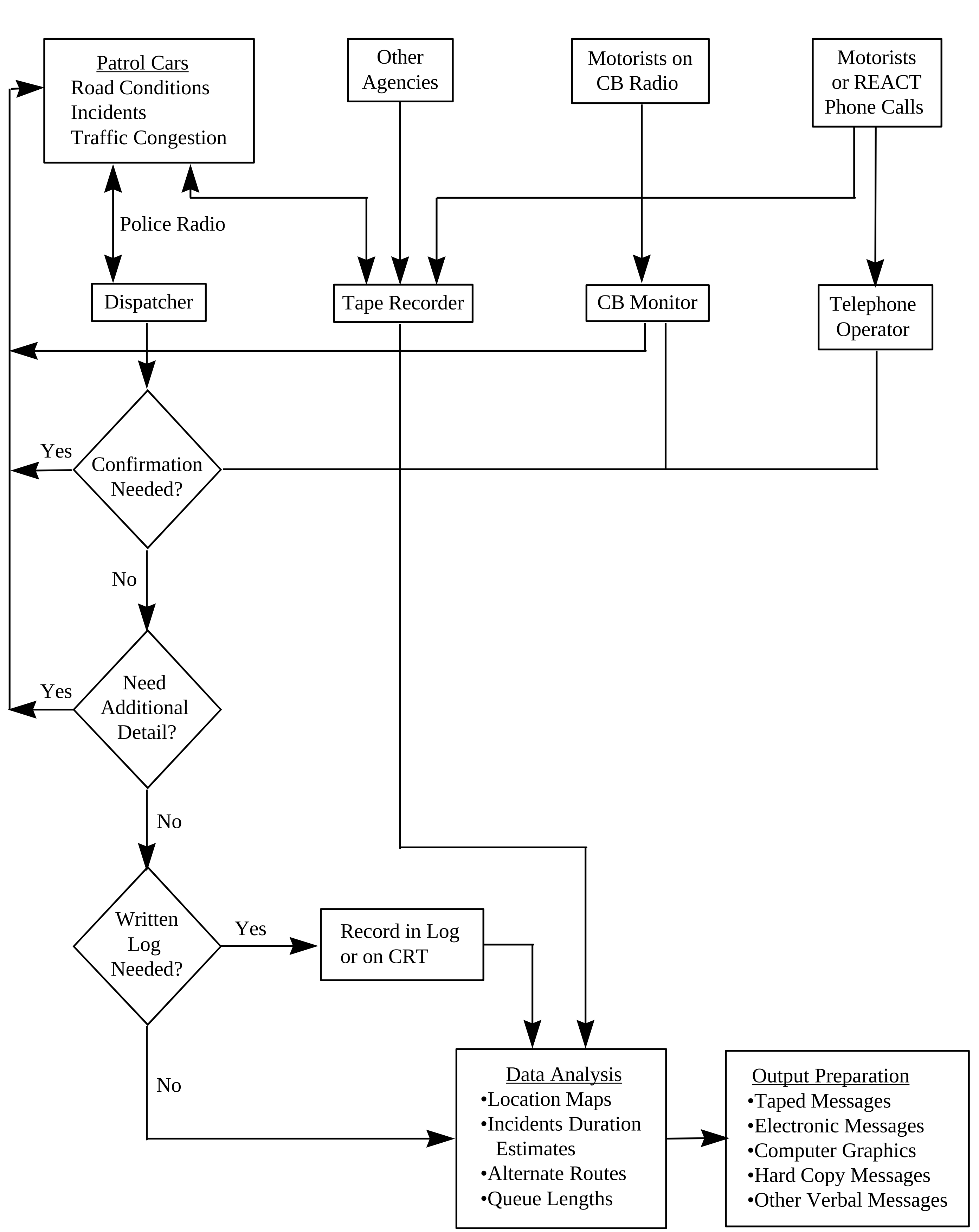
It must be recognized that the processes described can vary significantly among individual agencies, and that the discussion generalizes on the procedures involved. The ultimate objective of this analysis is to determine how consolidation center procedures might be improved or how their structures might be changed to produce more usable and timely information for the motorist.

Consolidation Centers for Dynamic Information Needs

In the sections below several existing consolidation center structures are used as case studies to illustrate the data reception, buffering, validating, analysis, and output preparation steps. The following examples are used:

- Police station acting as an initial consolidation center.
- Radio station or traffic information service acting as a primary consolidation center.
- Freeway surveillance and control system, acting as a primary or initial consolidation center.

Local or State Police - Figure 5 presents a flowchart of the consolidation process at a typical local or State police headquarters, showing the steps leading from data reception to output preparation. Information is received from a number of sources, including field officers (via radio) motorists (via phone or CB radio, if monitored) and other agencies, such as DOT's (usually via phone or written communications).



Consolidation Center Process at a Local/State Police Station	Figure 5

Typically, the dispatcher is in communication with field officers. These communications are usually taped, with the last time period (such as the last hour) available for reference, should there be a need to review the transmission that took place. Communications from other sources may or may not be taped. An individual other than the dispatcher would usually be monitoring CB radio or answering the telephone during peak periods.

The primary need for verification of information is with CB radio transmissions and motorists phoning in, since the reliability of the source is uncertain. Verification would include either on-site observation or the reception of similar data from other sources. Experience has shown that data can be verified relatively well with CB radio transmissions, as other motorists would usually be quick to correct a wrong location or falsified situation. Listening to CB radio transmissions is also a way to verify information initially obtained by other means.

For dynamic information, there is a need for verification in two primary areas, incident occurrences and roadway or traffic conditions. Incident occurrences and other emergency needs are of high priority, and the data reception and verification functions typically operate reasonably well at a local police headquarters, since this is one of their primary responsibilities. Traffic and roadway conditions, on the other hand, receive less of a priority, except where those conditions cause a threat to public safety, such as in a snow storm. Thus, a local police headquarters is not likely to spend a great deal of effort in obtaining and verifying traffic information, except in emergency situations. Other responsibilities simply have higher priority.

For information that needs verification, the dispatcher would request a field unit to respond. Even if verification is not necessary, more detail may be required before further action can be taken. This would also be a responsibility of the field units, or additional monitoring of CB radio may suffice, depending on the situation.

The buffering of information does not take place at the local police headquarters level. Normally buffering is thought of as a storage of information before anything is done with it. In this case, the information is being received and validated immediately as it comes in. However, buffering does take place in at least two ways at a secondary level. The tape recording of information would be considered a buffering process, as there may be a need to refer back to information previously missed. Figure 5 also indicates that certain information may be logged at some point, and this would also be a form of buffering.

Figure 6 shows a typical format for a radio message log at a police headquarters. Usually they are simple sheets on which hand-written messages are recorded. Typical entries would reflect:

- Times of occurrence of various incident-related events.
- Locations of incidents and traffic congestion.
- Actions being taken by officers at the scene.

An electronic system could also be used for recording messages, but would need to employ some sort of coding system to minimize the time required. The dispatcher usually uses a set of abbreviations or form of shorthand to minimize his writing time, and an electronic system would have to provide a similar time response.

SP35___Rev. 3-4-44

RADIO LOG OF KA5367 AND ________ SHEET • ________ OF ________ DATE ________ 19____

NO.	TIME	UNIT NO OR REF	MESSAGE	DISP INITIALS

Typical Police Radio Operator Log — Figure 6

The data analysis stage for dynamic information should involve the types of analyses indicated in Figure 5. As discussed previously, however, this type of information is not the highest police priority. When this type of data is collected, it is usually analyzed on a very general level. For example, one police group interviewed stated that, as a rule of thumb, an incident occurring at a major intersection during rush hour results in congestion that lasts roughly four times the duration of the incident.

Output preparation is also a relatively informal process at the police headquarters level. A radio station might call the police station to obtain status information or live interviews during periods of severe weather conditions or during major incidents, but it is generally not routine to maintain contact for continual updating of traffic information. Although all of the output formats listed in Figure 5 could be used, only verbal messages are typically available.

One of the case study reviews of existing operations was of the Virginia State Police. They operate State-wide, with a central office in Richmond and nine district offices. Troopers operate from the district offices where dispatchers and communications are centralized. The districts are connected to the central office computer via on-line terminals which can also access several data bases including the division of motor vehicles and the National Crime Information Center.

The State police have primary responsibility for patrolling interstate highways. They also patrol State routes in counties without interstate highways and in counties with small local police forces which need supplementing to obtain adequate coverage. The District office is therefore the receptor of data concerning many aspects of the roadway system.

The list of data sources at the district office is quite large, including radio reports from patrol cars, monitoring of CB radio, telephone calls from motorists or other citizens, and radio or leased phone line hook ups with other police and emergency service centers. Written reports also are received from the Virginia Department of Highways and Transportation (VDH&T) concerning expected road closings or other major activities which could affect traffic. Most of the data is received manually by the central radio operators who keep written logs on major incoming and outgoing messages. Tape recordings are also made of radio calls to and from patrol cars, but not of other sources.

Information consolidation is performed by the radio operators for on-going incidents. Normally two or three operators and two supervisors are present during the morning and evening peak traffic periods. Supervisors of the patrol officers also perform some consolidation by monitoring incidents or planning for actions in cases where disruptions to traffic are expected. During snow conditions, staff persons are assigned to answer phones and provide condition information. This information is obtained from VDH&T via telephone and from patrol officers via radio. Only general "corridor" information is prepared.

An important data aspect is that normally the police patrol officer is involved with resolving the causes of traffic delays or disruptions. Assistance from other groups such as local VDH&T offices is requested only when the incident cannot be resolved. Therefore, the police officer is often the primary and perhaps only official source for data concerning a roadway incident.

No computers are available currently at the district offices for traffic or roadway data storage or consolidation. All communications, except those with the central office or other district offices on-line with the terminal, are done via radio, telephone, or letter. Data storage other than accident- and crime-related is hard-copy in files.

Local or State Traffic and Highway Department - Although local and State traffic and highway departments have direct responsibility for the highway system, their role as a provider of information, except for the static information normally provided through highway signing, is unclear. Generally, information on construction and major traffic delays in which the highway department are involved would be communicated to radio stations via telephone. Highway departments also play a major role in communicating information on road conditions involving snow and ice. Other than these, there is generally little effort to consolidate traffic information for dissemination to the public.

One example of a State highway department operation is the Virginia Department of Highways and Transportation. VDH&T is responsible for virtually every aspect of construction, operation, and maintenance of the Virginia transportation system. As such, they are a typical State DOT group, representative of ones found in every State. There is a large headquarters staff and nine district offices. Cities in Virginia (and two counties) maintain their own roads, but VDH&T works closely with all local jurisdictions. In general, planning activities are centralized at the Richmond headquarters while operational aspects are conducted at the district and lower levels (residency and area office) with overall coordination by the central office.

A number of VDH&T's activities directly affect motorist's needs. As the agency responsible for all aspects of the roads, they are aware of data concerning construction and maintenance activities which are planned or underway. They also know of any major unusual permanent or weather-related roadway conditions. They receive calls and comments from individuals frequently concerning trouble spots in the highway system. They respond to requests for assistance with some incidents from the State or local police, but often are not contacted until well after the incident occurs. This data is generally collected at the district or lower level and transmitted to Richmond on a predetermined reporting basis or immediately if a major incident is involved.

Data collection concerning the local roadway system is generally done manually with the receipt of data by phone or two-way radio. Detour and construction data is part of the daily activity and is kept in report-type formats. A computer terminal allows for communication with the central office and other districts and for directly updating the State data base concerning construction projects. They have few standard procedures for making information available to other groups. One is for telephone calls to be made to a media list to aid in information transmittal in case of a severe incident. They also provide detour and other roadway information upon request.

During snow emergencies, extra persons are assigned to answer district phones to provide roadway condition information. Reports are obtained from the area offices on a predetermined basis via phone or radio, using codes for conditions on the routes in each area.

Hartford, Connecticut's Transportation Services Bureau is a good example of a local transportation agency. The operation, construction, and, to a lesser extent, the maintenance of the transportation network in Hartford, Connecticut is the responsibility of the city's Public Works Department. Operational concerns, such as signal timing and motorists information, fall under the purview of the Transportation Services Bureau (TSB) which is one of several agencies which comprise the Public Works Department. Representatives from the Transportation Services Bureau (e.g., city traffic engineer and assistants) are generally involved in any actions concerning significant changes in the roadway conditions such as construction activities or weather-related phenomena.

Portions of city streets are often closed for repair or to avoid construction activities on adjacent land parcels. The traffic engineer is the focal point for these and reviews all requests for street closures in consultation with the police, fire department, and other bureaus of public works. Prior to any street closure, the TSB informs the merchants in the vicinity as well as major employers in the city (e.g., Aetna, Travellers). Press releases are also distributed to local newspapers and radio and television stations. This street closure information includes location, dates, times, and routing and detour information as may be required. This information is prepared manually, and files are kept on the requests and actions.

Street closures which are the result of emergency events, such as water main breaks or failures in the infrastructure, are handled in much the same way except that decisions and the resulting actions are concentrated in a much shorter time frame. Data are collected and a plan for street closures and detours is prepared. This plan is then provided to the press and major employers via the telephone rather than a written notice. Again, the receipt of the data and consolidation are done by the TSB, with the decisions focused on the senior staff and traffic engineer.

Hartford, Connecticut receives an average of 50 in (127 cm) of snowfall each winter, thus snow emergencies are not uncommon. Snow emergencies are declared by the traffic authority (i.e., director of public works in consultation with police, fire, and the traffic engineer). When this occurs, a snow command center (located adjacent to the public works and traffic engineering offices) is manned continuously by representatives from the transportation services bureau, public works, police, fire, civil preparedness, and the housing authority. Representatives from the TSB are also out in the field monitoring the towing and plowing operations, and transmitting appropriate data to the command center via radio. One of the major problems encountered during snow removal in Hartford is the presence of parked cars (i.e., curb parking). When a snow emergency is declared, City vehicles travel down selected neighborhood streets (depending on the current towing priorities) with a vehicle-mounted loud speaker announcing that a snow emergency has been declared and that parked cars must be removed (usually within an hour) or they will be towed. The snow command center informs the press and major employers via telephone whenever a snow emergency has been declared. Information is also released on a continuing basis as to the status of the snow removal operations.

The TSB does not get involved with minor incidents (accidents, signal malfunctions) unless its assistance is specifically requested by the police or other agencies. (Note: Signal maintenance in Hartford is the responsibility of the fire department, not the TSB). Whenever staff do go out in the field to assist with an incident, they are generally equipped with radios, so that the central office can be kept informed. However, incident information is only passed on to the press or others if there is a major incident and after coordination with the police or other responsible groups.

Freeway Surveillance and Control Center - A freeway surveillance and control system (FSCS), normally operated by a branch of the DOT, presents one of the potentially best environments for consolidating and transmitting motorist information. The two major drawbacks of such a system for information consolidation purposes are the limited coverage of the systems and their high cost. However, the functional aspects of a freeway surveillance and control center are important to examine since such systems represent the state-of-the-art in data and information handling and since lessons may be drawn from their operation which apply to other aspects of consolidation centers. In addition, it is possible that the motorist information elements of surveillance and control center functions might be directly applied in locations where a full surveillance and control system is not practical.

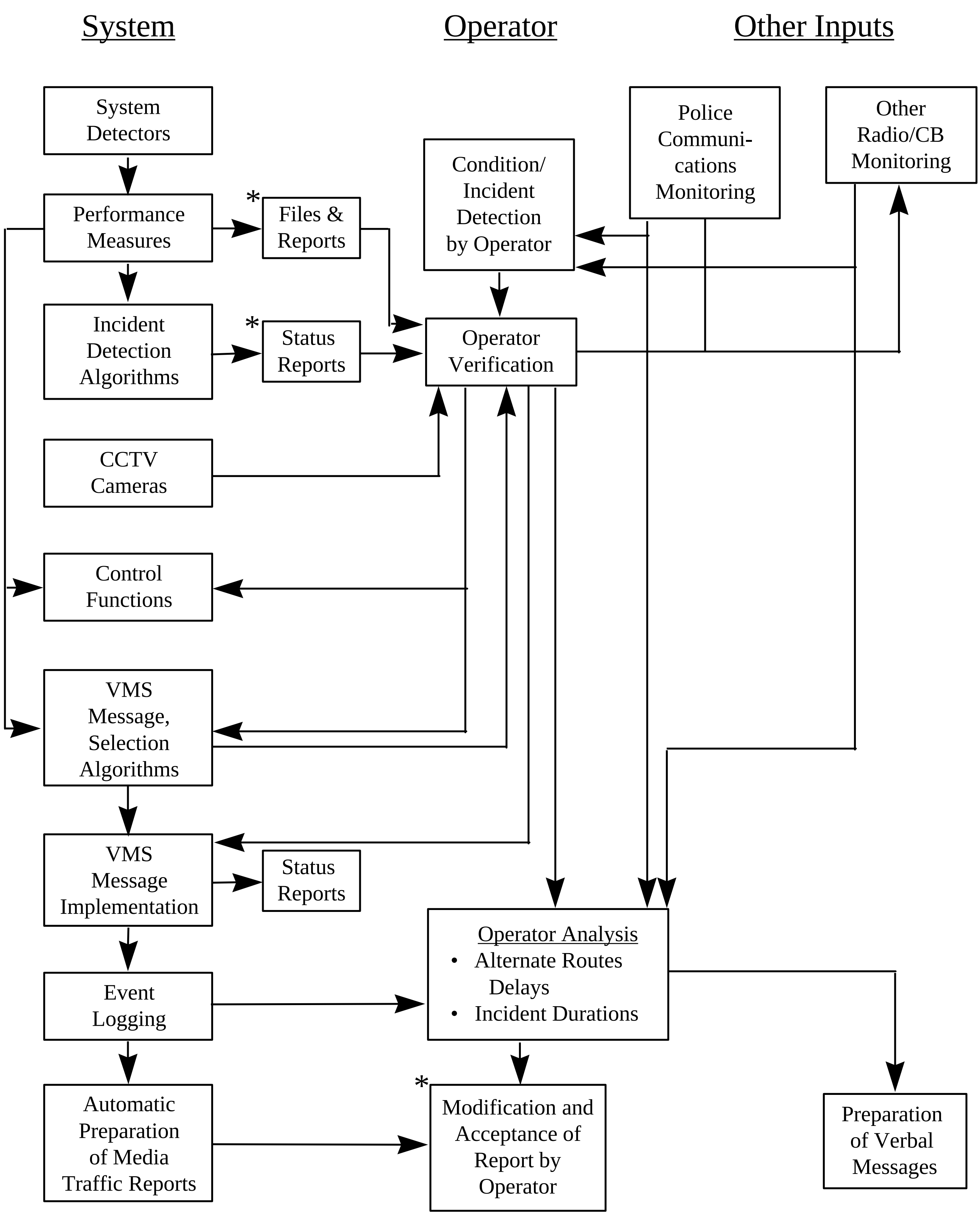
Figure 7 illustrates the typical flow of data through a FSCS control center, beginning with input from various sources and ending with output preparation. The figure has been arranged in three basic columns, the left column identifying system functions, the middle column identifying operator functions and the right column identifying inputs from other sources.

A FSCS has one primary source of data not available to other information systems: electronic vehicle detectors. In addition, many systems have closed circuit television cameras to permit visual observation of traffic, primarily for incident verification. CB radio monitoring has also been found to be an effective and low cost method of incident verification, and this technique is being implemented on the Integrated Motorist Information System (IMIS) on Long Island, New York. It has been developed and used previously in the Chicago FSCS.

In a FSCS control center, the central computer takes over parts of the data reception, analysis, and output preparation steps of the consolidation process. The function of the control center operator becomes primarily verification of events detected by the system and review of plans or messages generated by the computer. The human element is still a vital part of the process, insuring that false events are screened out and that information given to the motorist accurately reflects conditions.

The data reception function of a FSCS control center includes the reception of detector data by the central computer as well as the monitoring of police, CB and other radio channels and the normal telephone communications. Detector data is usually buffered either in arrays in the computer's memory or on disk files. One of the control center operators receives the radio and telephone communications, but generally the information is not logged. The information is typically used by the operators to identify traffic conditions or incidents not yet detectable by the system and to verify events which the system has already detected.

The data verification and analysis stages are heavily interwoven in a FSCS control center. The central computer is most actively engaged in the analysis of data while the operator is primarily responsible for verification. Two primary analysis activities of the computer are the computation of traffic performance measures (typically volume, occupancy, and speed) and the detection of incidents based on those



*Reports may be available to remote users

Consolidation Center Process
for a Freeway Surveillance and Control System

Figure 7

performance measures. These analysis activities identify the location and extent of congestion much more rapidly and accurately than can be done with other systems. However, algorithms used to detect incidents may identify incidents which are not actually there or may fail to detect incidents which actually do occur. Therefore, operator review is needed at this stage, as illustrated in Figure 7.

Following operator verification of an incident, the system would typically prepare implementation plans for both traffic control (i.e., ramp metering and signal control plans) and variable message sign displays (if included in the system). The operator may be called upon to verify and approve the systems signing plans, while in other cases the plan may be implemented without operator intervention. Information for making these decisions is provided to the operator through a set of reports generated and updated by the system. The analysis routines and the structure of the interaction between the operator and the system vary widely from system to system.

The need for additional operator analysis will also vary from system to system. Operator analysis may entail an assessment of alternate routings under certain conditions which are too complex or unusual for the system to analyze. One important component of the analysis process is anticipated incident duration, a variable which the system cannot predict. Depending on the system, the operator may be required to provide the system with estimates of incident duration throughout the course of the incident to enable the system to perform its analyses more accurately.

A variety of reports are generally available on system performance, incident status, sign status, and other aspects of operation. Figure 8 shows a typical incident status report which is available to the operator at the Howard Frankland Bridge in Tampa, Florida. On this particular report, the computer is managing three incidents. All have been confirmed by the operator, who has estimated the duration. The appropriate CCTV camera for viewing the incident is noted. This report could be provided to other groups for their use, as well as used by the operator.

Computer graphics are being increasingly used to identify overall congestion levels. The operator may choose to display one of several different traffic performance measures on a base map, and the system will automatically update the information. More detailed information can be obtained by calling up one or more of the traffic performance measure reports. The graphics capability has significant advantages in providing motorist information, as it can be electronically transmitted to radio stations and even rebroadcast over television.

The next level of reporting which is possible, but not frequently used, is the preparation of messages which can be electronically sent to and directly used by the media. The ability exists for the computer to take traffic performance data and integrate it with a standard message format to create a traffic report automatically without significant input from the operator. As with most other system operations, however, the operator would be required to verify the system-generated message for accuracy and add any of the detail on unusual conditions which the system was not able to provide. In addition to these system-generated messages, the logging and record keeping features of the central computer make it advantageous to record and transmit additional information. Figure 9 shows one such application from the Los Angeles traffic control system, this being a daily schedule of construction activities.

Date: 84 01 01 — Time: 00 16

Time	Incident ID	Station ID	Lane	Type/ Source	Resp Plan/ Sever. Level	Incident Status	ht. Lnd	CCTV Camera
00:03	31	N-07	I	Accident/ Alg: A	05/00	Confirmed	47	5.6
00:03	32	so9	2	Stall/ Alg: B	06/00	Confirmed	33	5.6
00:15	151	N-04	2	Accident/ CB Radio	06/00	Confirmed	34	3.4

(From Print-out, Howard Frankland Bridge, Tampa, Florida).

Incident Status Report - Incidents in Progress

Figure 8

```
***************** T R A F F I C  A D V I S 0 R Y *****************
FROM THE CALTRANS/CHP TRAFFIC OPERATIONS CENTER: THE FOLLOWING PLANNED LANE
CLOSURES ARE SCHEDULED FOR *TODAY*.

     IN THE EL TORO AREA, THE 4 RIGHT LANES (OF 6 LANES) OF THE SOUTHBOUND SAN
DIEGO FWY (RTE 5) FROM EL TORO CREEK TO EL TORO RD BETWEEN 6:00 AM AND 12:00
NOON FOR PAVEMENT MARKING.
1.   ALSO CLOSED: THE RIGHT LANE OF THE SOUTHBOUND SAN DIEGO FWY (RTE 405) FROM
IRVINE CENTER DR TO THE ROUTE 5 INTERCHANGE AND THE LAKE FOREST DR AND EL TORO
RD ON AND OFF-RAMPS TO THE SOUTHBOUND SAN DIEGO FWY (RTE 5).
2.   IN THE WEST LOS ANGELES AREA, THE CONNECTORS FROM THE WESTBOUND SANTA MON-
ICA FWY (RTE 10) TO THE NORTHBOUND AND SOUTHBOUND SAN DIEGO FWY (RTE 405) BET-
WEEN 6:30 AM AND 11:00 AM FOR MAINTENANCE
     ALSO CLOSED: THE OVERLAND AVE ON-RAMP
3.   IN THE TUSTIN AREA, ONLY THE LEFT LANE WILL BE OPEN* ON THE SOUTHBOUND
NEWPORT FWY (RTE 55) AT EDINGER AVE BETWEEN 6:00 AM AND 12:00 NOON FOR BRIDGE
REPAIR.
     ALSO CLOSED: THE MC FADDEN AVE ON-RAMP AND THE EDINGER AVE OFF-RAMP.
4.   IN THE NORWALK AREA, THE RIGHT LANE OF THE SOUTHBOUND SANTA ANA FWY (RTE 5)
FROM ORR & DAY RD TO PIONEER BLVD BETWEEN 6:00 AM AND 10:00 AM FOR GRADING.
     THE ORR & DAY RD ON-RAMP WILL ALSO BE CLOSED.
5.   IN THE SANTA FE SPRINGS AREA, THE RIGHT LANE OF THE SOUTHBOUND SANTA ANA
FWY (RTE 5) AT ALONDRA BLVD BETWEEN 6:00 AM AND 12:00 NOON FOR STEAM CLEANING.
6.   IN THE SHERMAN OAKS AREA, THE CONNECTOR FROM THE SOUTHBOUND SAN DIEGO FWY
(RTE 405) TO THE EASTBOUND AND WESTBOUND VENTURA FWY (RTE 101) BETWEEN 6:30 AM
AND 1:00 PM FOR BRIDGERAIL REPAIR.
     ALSO CLOSED: THE BURBANK BLVD ON-RAMP TO ROUTE 405 AND THE HASKELL AVE OFF-
RAMP TO ROUTE 101.
7.   IN THE HUNTINGTON BEACH-FOUNTAIN VALLEY AREA, THE 2 LEFT LANES OF THE
SOUTHBOUND SAN DIEGO FWY (RTE 405) FROM MC FADDEN AVE TO BUSHARD SC BETWEEN
6:30 AM AND 11:00 AM FOR CRACK SEALING.
8.   IN THE DOWNTOWN LOS ANGELES AREA, THE CONNECTORS FROM THE WESTBOUND SANTA
MONICA FWY (RTE 10) TO THE NORTHBOUND AND SOUTHBOUND HARBOR FWY (RTE 110) BET-
WEEN 7:00 AM AND 11:00 AM FOR CRASH CUSHIONS.
     ALSO CLOSED: THE 3 RIGHT LANES OF WESTBOUND ROUTE 10 FROM LOS ANGELES ST TO
ROUTE 110 AND THE MAPLE AVE ON-RAMP.
DATE 3/11/84                    TIME: 6:42 AM               BY OPERATOR #156
****************************************************************************
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Example of Computer Generated Report on Construction Sites and Roadway Closings	Figure 9

One good example of a freeway surveillance and control system tied into the information network is the Chicago Traffic Systems Center (CTS), operated by the Illinois DOT. It includes three major freeways covering about 110 mi. (177 km) of limited-access roadways. This is one of the largest systems of its kind in the country. Data are collected through a variety of electronic means, including: loop detectors (vehicle sensors in the pavement), courtesy patrols, CB radio monitoring (with a relay system), motorist aid call boxes, and the reception of calls from police, traffic agencies, and others.

The data are received manually or electronically, and maintained in a central computer at the control center. The computer connects with the variety of devices for transmitting information to motorists, which include variable message signs and highway advisory radio, as well as ramp metering and other traffic control. Also, the computer system provides information on delays and conditions on graphics displays, which can be sent to radio stations, other media, and other commercial users via a terminal connection. Radio stations are permitted to have access to either the text or graphics information, provided they pay for the connection. Credit must be given to the control center in any broadcast using the system's information. The central office is manned 14 hours per day.

In spite of all the automatic features provided by a FSCS control center, there are occasions when the system operator or another representative might be called upon to provide a verbal analysis of traffic conditions for media broadcast or some other purpose. Although this is no different from a verbal analysis from a typical police or highway department, the operator of the FSCS is likely to be much more informed about traffic conditions by virtue of the substantial system capabilities. As stated previously, however, surveillance and control systems cover significant portions of the street system in only a limited number of urban areas.

Radio Stations and Traffic Information Networks - The two consolidation center types previously discussed represent intermediate stages of data consolidation. The major exception to this is the FSCS with variable message sign capabilities, in which the control center does serve as the primary consolidation point. The most common arrangement for primary information consolidation involves a commercial radio station, which typically assembles and prioritizes information in preparation for broadcast to the public. A station may have its own traffic reporting team in addition to gathering data compiled at the intermediate stages by other agencies.

In recent years, several private traffic information services have arisen in major metropolitan areas (e.g., Shadow in the New York City and Philadelphia areas, and Metro Traffic Control in a number of metropolitan areas). These organizations solicit local radio and television stations to subscribe to their services, much as they would subscribe to a news or weather service. So far, there has been only one such organization within each metropolitan area, although the possibility exists for competing organizations to be established. In essence, the traffic information service concept allows more comprehensive and coordinated coverage of an urban area and brings all of the available information to a single focal point. The fact that such organizations have arisen on their own indicates that there is, in fact, a market for such information. The question remains, however, as to how FHWA or other government agencies can and/or should be involved in enhancing their operations or supporting the establishment of additional similar organizations to serve as consolidation centers.

The arrangement for a primary consolidation center can vary even more widely than some of the other consolidation center types. Figure 10 shows one generalized arrangement for a center established for a private traffic information service. The other end of the spectrum would consist of a local radio station which simply keeps in contact with area police and highway agencies but does little of its own data gathering. The more comprehensive case will be the focus of this discussion, since this is more likely to provide insight on how to improve consolidation center operations.

A private traffic information service employs the most diverse set of data sources of any of the systems. Consequently, the data reception requirements are equally diverse. In addition to the information from other agencies, the service employs its own traffic observers and usually monitors other sources such as CB radio directly or through REACT. Most of the methods of data reception and buffering have been mentioned previously. Certain of the methods will be similar to those employed in intermediate consolidation centers, such as police stations. However, since collecting traffic information is the primary function of the service, it is expected that there would be greater emphasis on recording and organizing traffic performance data.

In the Shadow traffic network, (based in the New York metropolitan area) data is received from a multitude of sources, including 10 ground-based traffic observers (only 2 of which are full-time employees), 7 aerial observers, telephone contacts with a multitude of local agencies, and 15 “shadow boxes”. Shadow boxes are remote listening posts consisting of CB radio retransmitters located along heavily travelled commuter corridors which enable monitoring of and direct contacts with motorists via CB radio. The plans for the Integrated Motorist Information System (IMIS) which will provide surveillance and control over portions of major freeway and arterial links on Long Island, include a computer link between the IMIS and Shadow. Relevant information from all the sources is directly recorded in a computer terminal, using a system of coding devised specifically for that purpose.

In the Shadow traffic network, data verification and analysis are performed primarily by two producers. The producers maintain direct contact with many of the data sources themselves and are responsible for filtering and prioritizing significant information and for entering valid data in coded form on the microcomputer system. The information is displayed on seven separate networked microcomputer terminals used by announcers who make live traffic reports for subscribing radio stations. Thus, the verification and analysis process is taking place rapidly and continously and is based on the judgement and experience of two or three key individuals. It requires the ability to remember and assess the importance of a large quantity of data in short periods of time. Although tools have been developed to make the data analysis process easier and faster, the process primarily relies on the unique ability of a human to link together events and make judgements on the degree to which information will be useful to the motoring public.

As could be expected, the output preparation function for a radio station or private traffic service is oriented toward commercial radio broadcasts. In many cases live reports may be aired from aerial or ground-based traffic observers or from someone at a private traffic service headquarters or at the radio station itself.

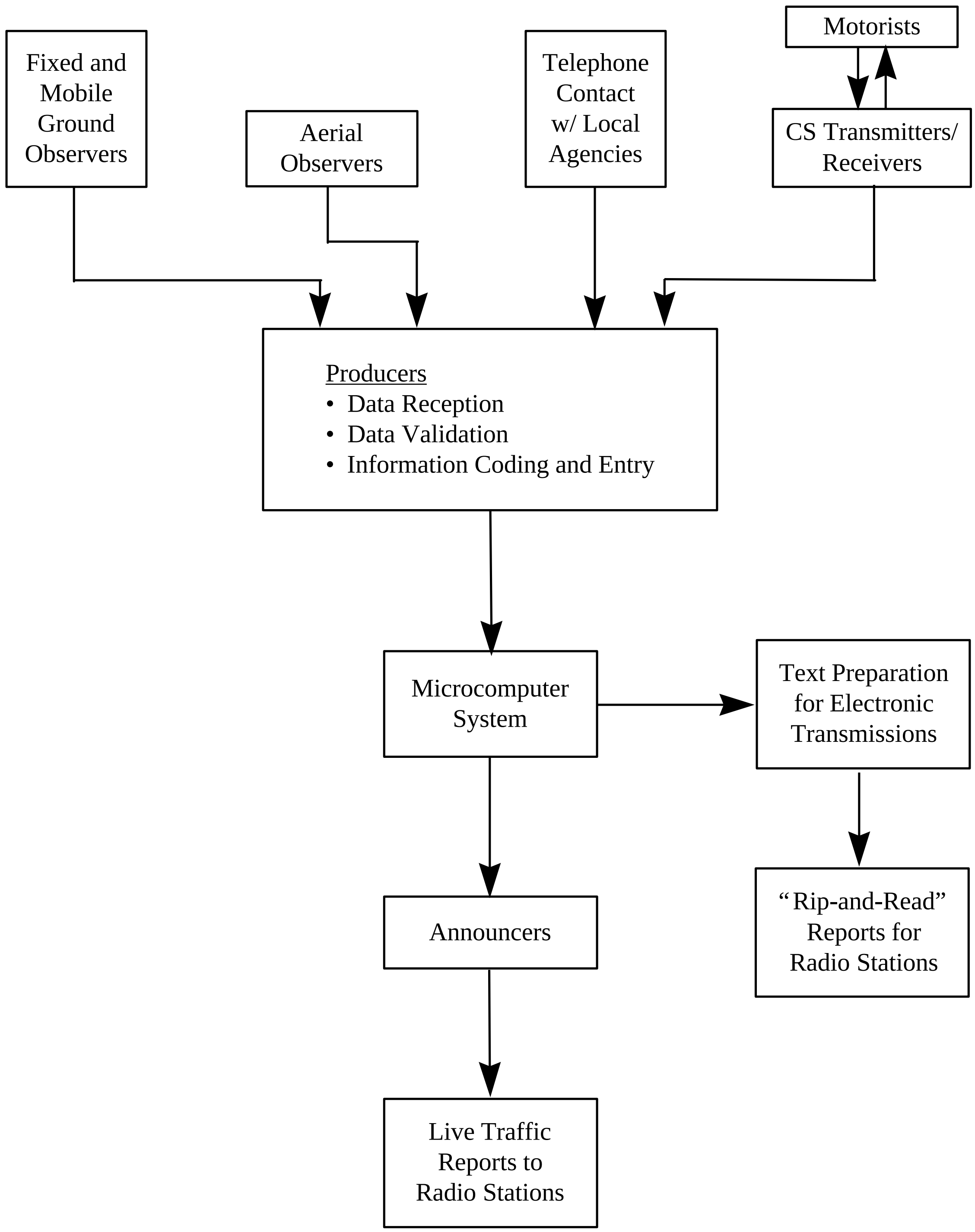


Illustration of Information Flow for the Shadow Traffic Network

Figure 10

In the Shadow network, output preparation consists simply of an announcer verbalizing the coded traffic information on the CRT. A schedule is established for reports to be aired over the various subscribing stations, and the announcer will connect with the radio station at the appropriate time to present the report.

A second type of report produced by Shadow is called a “rip-and-read” report. These are teletype-like reports which are used by approximately 13 of the 56 subscribing radio stations. A computer operator takes the in-house codes prepared by the producers and translates it into text which can be electronically sent to the subscribing radio stations and directly read over the air. To the extent possible, traffic reports are tailor-made for specific radio stations, as the stations prefer to emphasize activity within their listening area.

Metro Traffic Control (MTC) is another private firm that provides localized traffic condition reports to radio/TV stations and other commercial users. In each urban area where they operate, they use a combination of data collection techniques consolidated in a central office to keep track of delay locations and other problems with the travel network. The data comes from fixed and roving observers on the ground, airborne observers, monitoring of CB and emergency radio networks, contacts with the transit system and police dispatchers, and even traffic reporters on other radio stations.

At the central office, all the data is collected using tape recording or written logs. After verification and editing, traffic information is provided to radio stations via live or taped reports and is entered into a microcomputer for electronic transmission to selected stations. Graphics for TV broadcast are also provided. A large map can be used to keep track of problem locations. Generally three to four persons are in the central office during a peak period, operating the computer, receiving data, and actually making the broadcasts used by some stations.

MTC primarily operates during peak periods. However, they provide some midday information, as well as special reports such as weekend beach-traffic reports if requested by a subscribing station. Also, if a major incident has occurred, they will collect and prepare appropriate information throughout the duration of the incident. The collection and consolidation procedures here are the same as those used during peak periods. Portable two-way radios are frequently used by observers in special incident situations, to allow for reporting "from the scene” in a timely fashion. MTC is currently operational in 13 cities.

Consolidation Center for Semidynamic Information Needs

There are fewer examples of consolidation center operations for semi-dynamic information than there are for dynamic information. One excellent example is an auto club which compiles a variety of data for pretrip and enroute use. Figure 11 illustrates the flow of information for AAA, which will serve as the specific case study to be discussed.

One of the primary data sources for AAA consists of groups of field representatives who travel the interstate and primary road system once per year to verify travel time, tolls, and service information, as well as to make inspections of

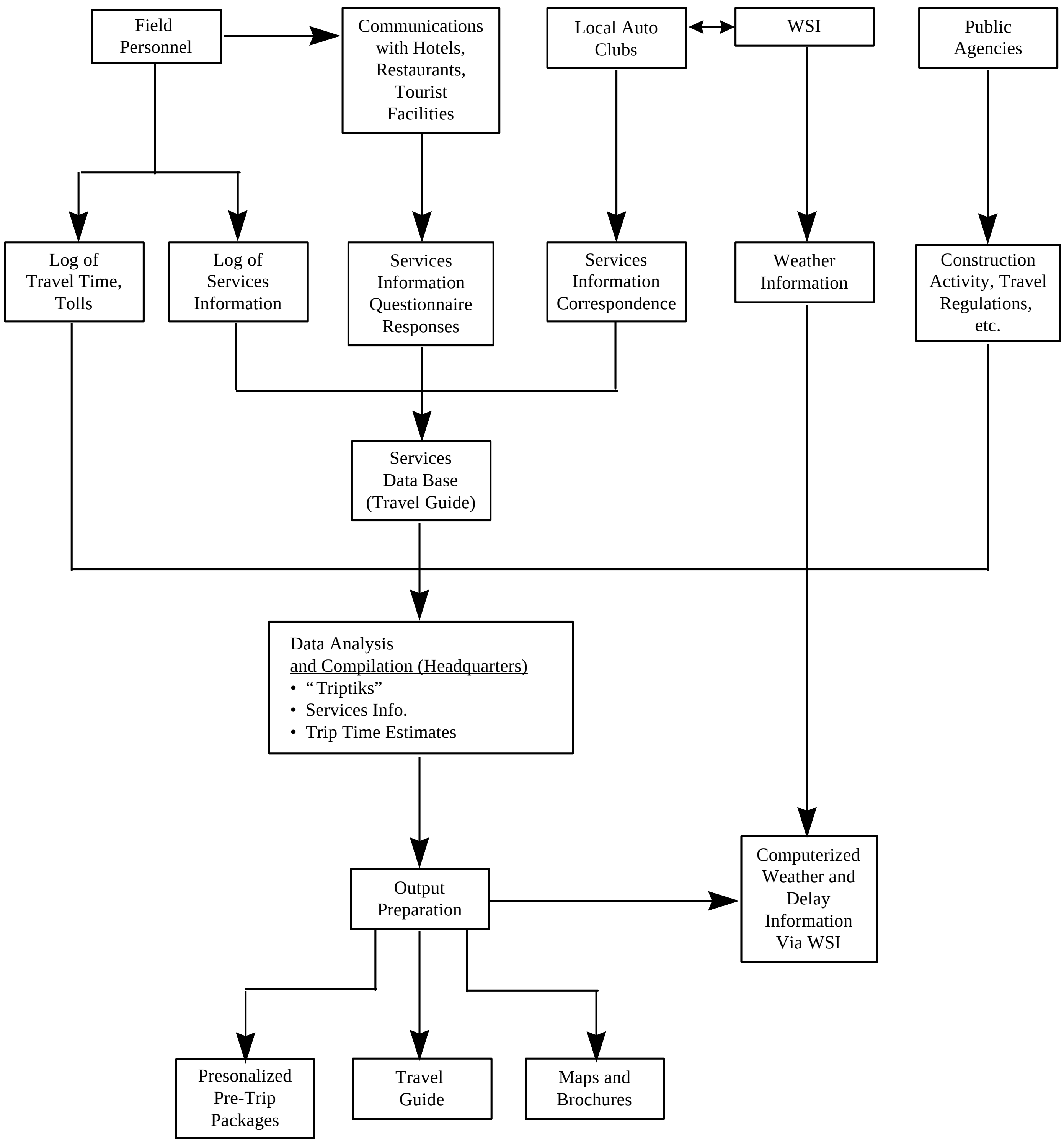


Illustration of Flow of Information at AAA

Figure 11

facilities. The results are recorded on logs and sent to headquarters for compilation. Hotels and restaurants approved by AAA are sent computer-generated questionnaires annually requesting updated information on facilities and rates. Local auto clubs may also provide some of these data to the national headquarters. In addition, data are requested from highway agencies concerning construction activity and other events relating to highway travel.

To obtain weather information AAA is equipped with terminals connected to the WSI, a private weather service. In return, they provide WSI with travel-related information. WSI combines the weather and travel data to provide reports accessed electronically by their subscribers. AAA uses the weather for similar club member reports.

Data verification takes place in the process of its being compiled. Generally, the data received from all sources are quite reliable, and only basic editing and checking for errors need to be done prior to its entry into the system. Services information on logs, letters, and memoranda are entered into a set of data bases used for printing the regional tour books. Figure 12 shows a typical page from one of the tour books. Modifications of and additions to the data are made as they arrive, and the contents of the data base are printed annually.

Information on other motorist services are compiled in a set of documents which are used by travel counselors in assisting motorists in the planning of trips. A route manual is compiled from travel time information obtained in the field. Construction activity and noteworthy traffic regulations are illustrated on maps such as the one shown in Figure 13. Using this information, the counselor manually highlights the fastest route or an alternate preferred by the motorist and identifies construction activity and regulations along that route. Thus, the analysis stage consists of modifying these materials as new information arrives. The maps showing construction activity can be updated as often as twice a week, but each individual map is normally changed about every 3 months (since major construction activities change somewhat slowly).

Most of the outputs of the consolidation process have already been mentioned. These products are used exclusively for personal travel counseling. Information which may change on short notice is transmitted to the motorist manually by marking up a map or a "Triptik" (a bound strip map with general travel information included). Less volatile information is usually available in printed form.

Although AAA may be a prime example of semidynamic information consolidation, this activity also occurs within other structures. A hotel chain, for example, has its own process of compiling and printing hotel location and rate information. The telephone company also consolidates and prints such information in individual advertisements in the yellow pages. These processes are usually quite streamlined, having evolved over a long period of time. They now typically include automated data entry and output formatting.

Consolidation Centers for Static Information Needs

Static information, consisting primarily of highway signs, is handled through local and state highway agencies. The consolidation process is difficult to diagram or

AB2 VIRGINIA

KEYSVILLE (23947) - 700

Sheldon' s Motel — Rates Subject to Change — *Motor Inn* ♦♦
All year 1P 20.00 - 24.00 2P 1B 24.00 - 30.00 2P 2B 30.00 XP 2
31 units. 1 mi n at North Keysville exlt st jct US 15 & 360. then 14 mi s on US 15 & 360 business rt. (Rt 2. Box 169) Few smaller, older units not recommended. AC. CTV. 27 radios, phones. Pets. AE. MC. VI. * Restaurant. 6:30 am-10:30pm, $4-$8.95. wine. (804) 736-6434

KIPTOPEKE BEACH - 5.r CAPE CHARLES

LEESBURG (22075) - 8,400

Sigwick Inn and Golf Club — AAA Special Value Rates — *Motor Inn* ♦♦♦
All year 1P 45.00 - 50.00 2P 1B 5500 2P 2B 50.00 XP 5 F
130 unlls 1 1/2 mi s on US 15 & SR 7 s1 jct US 15 business rt. 1100 Clubhouse Dr (Box 1334) Formerly Quality Inn-Leesburg. AC, CTV, phones, Sultes, Pool, wading pool, golf - 18 holes Fee for driving range. Airport transp. Pets. 65 extra chrage *AE,* CB, DI, MC, VI. * Restaurant, outdoor terrace, in summer, 7 am - 2 & 5-9 pm. $7- $13. cocktails. entertainment. (703) 777-1910

Weona VIIla Motel — Rates Guaranteed — *Motel* ♦
3/1 - 1/31 2P 1B 26.00 2P 2B 30.00 - 34.00 XP 4
6 units. 11 1/2 mi w on SR 7. (00; i41. Round HillfP2~~41) OPEN 3 1.1 31 Excrpl1on4lly well-kept rooms. AC CTV. comb or shower baths Reserv deposll required. MC. VI. (703) 336-7006

LEXINGTON (24450) - 7,300

Best Western Keydet General Motel — Rates Subjoel lo Change — *Motor Inn* ♦♦♦
3/15 - 11/30 1P 30.00 - 34.00 2P 1B 34.00 - 40.00 2P 2B 38.00 - 46.00 XC 4
56 units On US 60. 4 1/2 mi w of I-61. exit 51W (RFD 1, Box 10) OPEN ALL YEAR Hillside location with a scenic view 11 refrigerators, AC, CTV, 20 radios, phones. Suites, AE. CB, DI., MC, VI. * Restaurant, see separate listing (703) 463.2143

Econo Lodge — Rates Subject to Change — *Motel* ♦
All year 1P 27.95 2P 1B 32.95 2P 2B 35.95 XP 4
46 units on US 11 at jct l-64 * x11 13. (Box 1066) AC. C CAN; phones. AE, CB, DI, MC, VI. (703) 463-7371

Holiday Inn — Rates Subject to Change — *Motor Inn* ♦♦
All year 1P 3200- 36.00 2P 1B 37.00 - 46.00 2P 2B 37.00 - 46.00 XP 4 F
72 units 2 mi n on US 11 s of jct l-64 (Box 1108) AC C CATV movies phones Pool wading pool Pets AE CB DI M C V I *Restauranl 6am-10pm $7 - $14 cocktails (703) 463-7351

Howard Johnson' s Motor Lodge — Rates Subject to Change — *Motor Inn* ♦♦♦
All year 1P 26.00 - 41.00 2P 2B 3200 - 45.00 XP 5 F
100 units. 5 3/4 mi n on US 11 at jct l-64 & 61. exit 53 (Box 1074) AC. C TV, radios, phones Coin laundry Pool. Pets. AE, CB, DI, MC, VI * Restaurant, 24 hrs, $5.50 - $10.50, beer & wine. (703) 463-9181

RESTAURANT

Keydet General Restaurant - in Best Western Keydet General Motel Scenic view Seafood featured Thurs buffet, AC A la carte entrees about $7.50 - $15 children' s menu Open 7 am - 3 & 5 - 10pm closed 12/25 Cocktalls MC VI (703) 463-7797

LURAY (22835) - 3,500

Holiday Inn — Rates Subject to Change — *Motor Inn* ♦♦
Fri & Sat 6/9 - 11/10 2P 2B 49.95 - 52.00 XP 5
Sun - Thurs 6/9-11/10 2P 2B 39.95 - 42.00 XP 5 F
3/23 - 6/6 2P 2B 37.00 XP 5
11/11- 3/22 2P 2B 32.00 XP 6 F
101 units on US 211 bypass. 1 24 mi s of jct US 340. (Box 612) AC. C CATV. phones. Pool No pets Reserv deposit required. 3 days retund notice 6/10 - 11/12. AE. DI. MC. VI. . Restaurant; 7 am - 2 & 5:30 - 9 pm. 5/28 - 10/31 to 10 pm, $5 95 - $12 95. beer & wine. (703) 743-4521

Intown Motel — Rates Subject to Change — *Motor Inn* ♦♦
4/2 - 10/31 2P 2B 39.00 XP 4
11/1 - 4/1 1P 24.50 2P 2B 27.00 XP 4
40 units 14 mi w on US 211 business rt 410 W Main St AC. C CAN. shower. phones. Pool. playground Pets. $3 charge Reserve deposit required 4/2 - 10/31 AE. CB. DI. MC. VI * Restaurant. 6:30 am - 2 & 5 - 9:15 pm: 11/1-3/31, 6:30 am - 10 & 5:30 - 8 pm. $6 - $11, cocktails. (703) 743-6511

Luray Caverns Motel - East — Rates Subject to Change — *Motel* ♦♦
3/1 - 11/15 1P 30.00 - 36.00 2P 1B 30.00 - 36.00 2P 2B 30.00 - 36.00 XP 5 F
40 units, 1 mi w on US 211 business rt 631 W Main St OPEN 3/1 - 11/15. Annex units not recommended AC. C CATV, comb or shower baths. 3 2-bedroom units. Pool, wading pool. Pets Reserv deposit required AE, MC, VI (703) 743-4531

Luray Caverns Motel - West — Rates Subject to Change — *Motel* ♦♦
5/22 - 11/29 1P 36.00 2P 1B 36.00 2P 2B 38.00 XP 5 F
15 units. 1 1/2 mi w on US 211 bypass w of jct US 211 business rt (Box 436) OPEN 3/14 - 11/29, AC, C, CATV, phones, shower or comb baths. Pool. wading pool, Pets Reserv deposit required. AE, MC, VI. (703) 743-4536

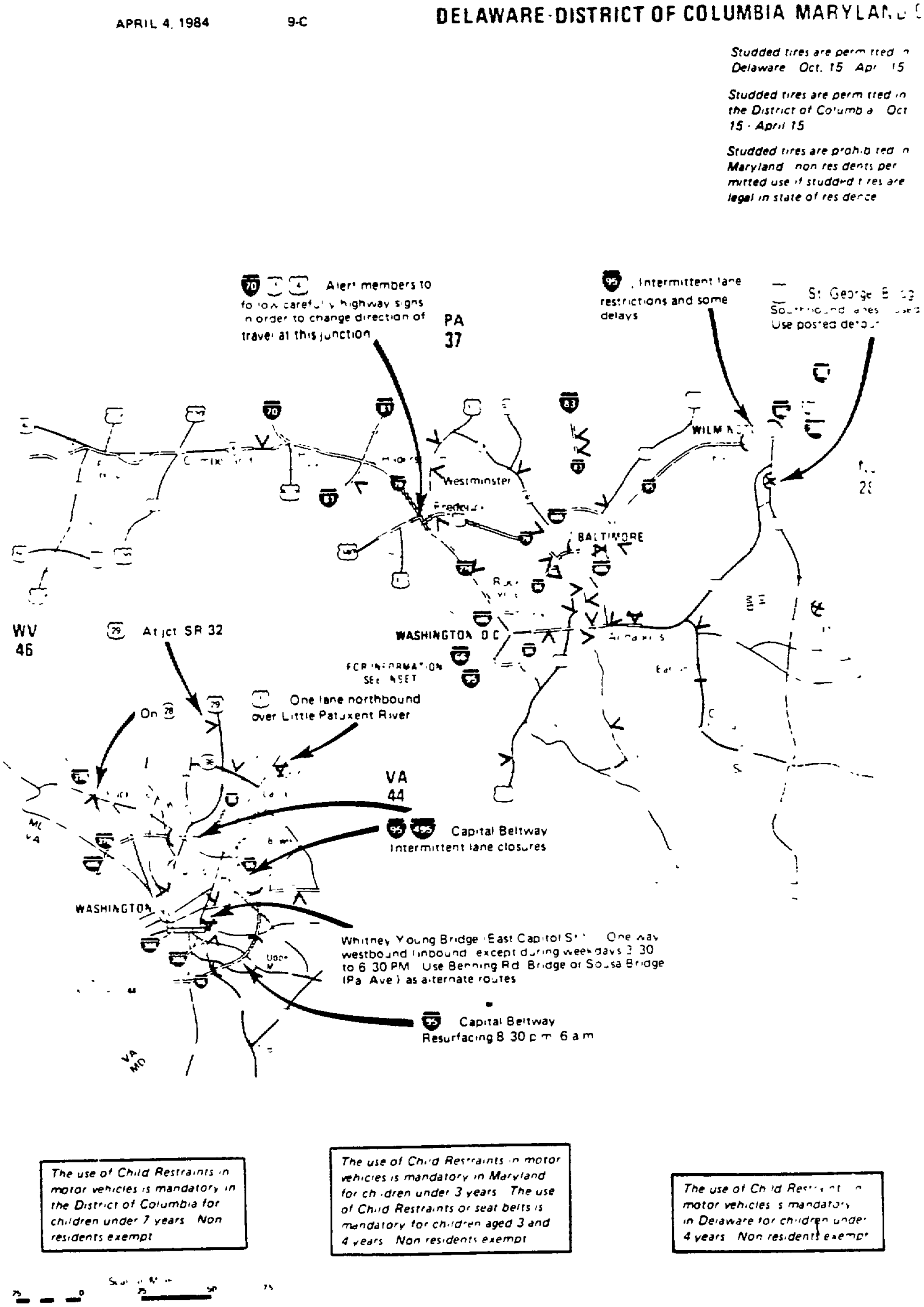
LYNCHBURG - 66,700

Crist Motel — Rates Subject to Change — *Motel* ♦♦
All year 1P 26.00 2P2B 34.00 XP 3 F
67 units. On US 29 business rt. 1 blk w of US 29 Expwy via Sk 128 2615 Candler & Mtn Rd (24502) AC, C, CATV. phones, Htd pool. AE, MC, VI. (804) 237-2986

Holiday Inn - South — Rates Subject to Change — *Motor Inn* ♦♦♦
All year 1P 33.00 - 43.00 2P1B 39.00 - 48.00 2P2B 39.00 - 42.00 XP 4 F
260units. 2 1/2 mis on US 29 Expwy Odd Fellows Rd exit 100 Odd Fellows Rd (24502) AC, C, CATV, radios, phones. Coin laundry Pool wading pool. AE, CB, DI, MC, VI * Restaurant 6 am - midnight, Sat & Sun from 7 am $7 - $13.95 cocktails

CONSULT YOUR LOCAL AAA OFFICE FOR ALL YOUR TRAVEL NEEDS.

Typical Tourbook Information Format — Figure 12



Reprinted by permission of the American Automobile Association.

Representative Map with Construction Information

Figure 13

summarize, as it usually involves an extended process of engineering and/or political reviews. Considerable effort has been invested over the years in developing standards and guidelines for signing, and a review of those here is not appropriate.

ALTERNATIVE TRANSMITTAL MEDIA

This section is concerned with all potential means for transferring information from consolidation centers to the motorist. This may occur through the print media (including newspapers and informational brochures), through all types of roadside signs, through wireline interconnections (such as the public telephone system and cable television), through licensed radio transmissions from terrestrial stations and satellites, and through a variety of unlicensed electronic means such as induction and low-power radiation systems. These categories include a large number of well-defined existing transmittal media which are already being used to transmit motorist information or could easily be adapted for this purpose.

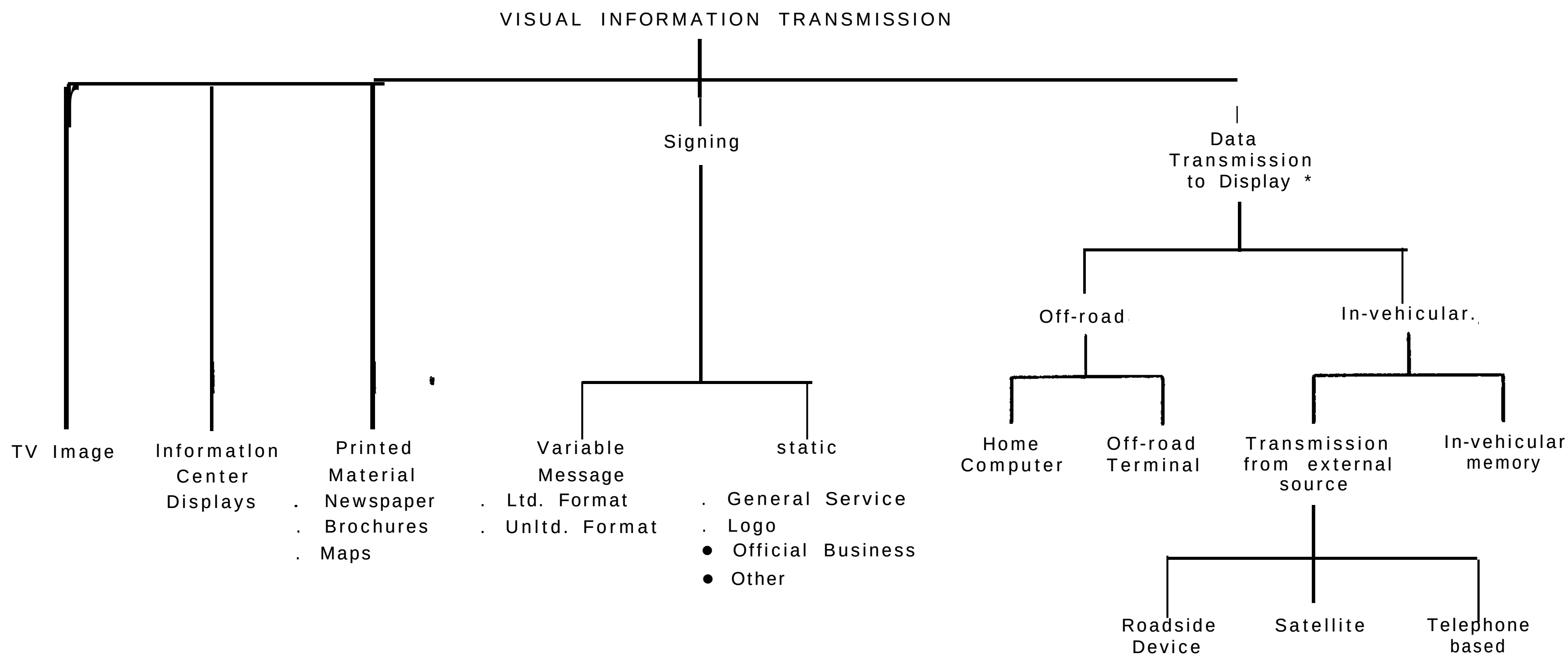
There are other transmittal techniques considered in this section which exist only as proposals, although most have been carried to the point of developmental testing. Some proposed systems could easily be implemented within present technology. Others may be dependent on emerging technology not yet fully developed. In some cases, the development of a new medium will depend not only upon the development of the technology, but on the allocation of frequencies or elimination of other regulatory or institutional barriers. Those media which show potential for MIS application, are discussed further in Chapter 4.

The purpose of this section is to initially define the range of possible transmittal media, both existing and emerging. Figures 14 and 15 present an overall classification of methods of transmittal. The basic stratification is on visual versus aural presentation. The figures include both existing and evolving future technology. Descriptions of the technology within each of these classes are presented in the sections below.

Compatability with Information Types

While the data collection and consolidation functions tend to be oriented toward particular types of information (dynamic, semidynamic, or static), many of the methods of transmittal can be applied to more than one information type. Once the information has been prepared, a variety of methods can be used to transmit the information to the motorist. However, certain transmittal methods are more effectively used with certain types of information.

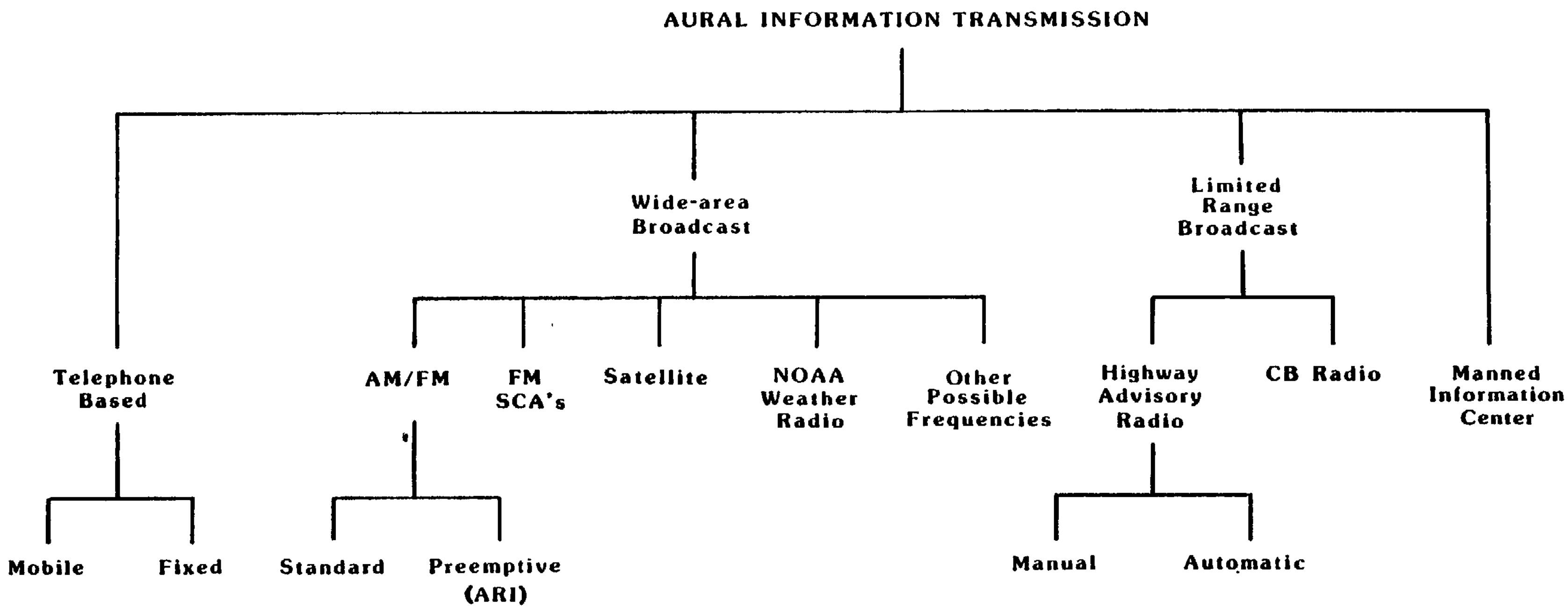
Because of the overlap of transmittal applicability to the information types, the discussion of transmittal media is not organized by information type as were the data collection and consolidation functions. Rather each of the transmittal media are presented individually, and comments are made as to their applicability to certain types of information, where appropriate.



* Could also be transmitted to motorists via aural means

Classification of Visual Transmittal Media

Figure 14



Classification of Aural Transmittal Media

Figure 15

Effect of Motorist Location

Some aspects of motorists' needs have been analyzed in terms of "pretrip" and "enroute" requirements. Pre-trip information is assumed to be received and assimilated at a fixed location such as the home or office. Enroute information is received and used after a trip begins. Preferably, enroute information can be delivered directly to the moving vehicle. Alternately, it can be made available at fixed, off-road locations. Generally, pretrip information may be needed for a large area or longer-distance location. Enroute needs primarily concern the local area, or locations within a few hundred miles at the maximum, since this is an area in which the vehicle will be operating before the driver stops.

From the point of view of transmittal media, the distinction between delivery of information to a fixed point and a moving vehicle is important. Any media requiring a wireline or cable connection is obviously limited to transmitting information to fixed points. Roadside signs, on the other hand, are best suited to delivering messages to moving vehicles. Some radio media are suitable for either.

Visual Versus Aural Presentation

All transmittal media deliver messages in either an aural or visual format. Some media, like television, use both. Others can be adapted to use both. Telephones, for example, would normally be considered an aural medium. However, the telephone network can also be used to transmit data, and data can be used to generate visual displays on a computer terminal, or provide voice messages.

The value of a CRT display for presenting traffic information at a fixed location may be obvious. Not so obvious is the value of a visual display to a motorist while operating a motor vehicle. No reasonable person would suggest that the driver of a vehicle be allowed to watch a typical television presentation. However, motorists do derive benefits from the visual displays presented by roadside signs and the displays of their own instrument panels without being unduly distracted from the task of driving. Many automobile manufacturers are presently developing microprocessor-driven CRT displays capable of presenting a wide range of information on engine and vehicle condition, fuel consumption, miles traveled, miles to go, and other information derived from on-board sources. Some of this may still be classed as "emerging technology." It would require no great advance in technology to adapt such a system to display information from external sources as well. In the evaluation of transmittal media, compatibility of each medium with computer-controlled visual or audible displays in the vehicle (as well as in the home or office) should be kept in mind.

Rural And Urban Coverage

The operation of most transmittal media is not affected by the population density of the operational environment.For economic reasons, however, many media potentia lly useful for motorist information are concentrated in urban areas. This is true of newspapers, broadcast and television stations, and radiotelephones. An effective motorist information service in rural areas is expected to be more difficult to provide. In the evaluation of transmittal media the compatibility of each medium with rural and urban service should be noted.

Identification of Existing Transmittal Media

Existing media are identified below for the purpose of comparison and analysis. Because they are existing, these media are well-defined. Frequencies (if used) are allocated and the rules of operation are well-established. If changes are required to better provide for the transmittal of motorist information, these are expected to be minor.

Daily Newspaper - As a transmittal medium for motorist information, a newspaper must provide more than an occasional road- or traffic-related news story. It is assumed for purposes of comparison that the newspaper carries a regular "motorist information" section that the motorist can easily locate and use. In format, it might resemble the weather section in USA Today, and weather forecasts might well be one type of information included. Newspapers would normally be procured and read before the beginning of a trip (though they might be consulted enroute). They are, therefore, considered most useful for pretrip information. Many newspapers now carry regular columns on construction and detour information. Newspapers would be oriented almost exclusively toward semidynamic information.

Informational Brochures and Maps - These are printed matter available upon request as aids in trip planning. To be useful from the point of view of this study, they must be more than promotional literature issued by tourist agencies. Information on route characteristics, roadway conditions, location of services, and toll information are typical of what might be included. Currently, membership organizations much as the American Automobile Association use this means of information transmittal. Such material should be useful for satisfying both pretrip and enroute information needs. Maps, in particular, are often available from off-road sources after beginning a trip and may be consulted enroute. A large amount of information can be conveyed in this medium at a generally low to moderate cost. A major disadvantage of all hardcopy materials is the fact that information contained can become easily outdated, and that often the motorist must take action to acquire them several days in advance of the trip.

Static Signing - This is the traditional medium for the transmittal of enroute information to the motorist. It requires no special equipment on the part of the motorist and it serves very well for information which does not frequently change (static information). It is, however, limited information content (because of the short viewing time from a moving vehicle), and it cannot be used to display rapidly changing information. Regulatory signs inform motorists of traffic laws or regulations and indicate the applicability of legal requirements that would not otherwise be apparent. Warning signs are used when it is deemed necessary to warn traffic of existing or potentially hazardous conditions on or adjacent to a highwayl. Design and placement of these signs are fully specified in the Manual on Uniform Traffic Control Devices (MUTCD) which results in these signs being well-coordinated and standardized. Guide signs, except for official business signs, are also fully specified in the MUTCD and therefore communicate the displayed information well.

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1 Federal Highway Administration, Manual on Uniform Traffic Control Devices (Washington, D.C., U.S. Government Printing Office, 1978-Revision I), pgs. 2B-1, 2C-1.

General Services signs provide directional information to unfamiliar drivers for facilities which supply the following services **or** accommodations: food, gas, lodging, camping, and hospital. Both word and symbol signs are in use in most States on the interstate system, expressways, and freeways. There is also limited use of these signs on rural trunk highways. While these signs are helpful, they have been criticized as not being adequate for the practical needs of the travelling public.[2] One criticism is the amount and type of information transmitted. Only the generic name of available services is used; *no* business or brand names are provided. In addition, no details concerning the specific service provided are displayed.

Serving the same purpose as general service signs, logo signs display business and brand identification for fuel, food, lodging, and campground facilities. Both motorists and businesses agree that these signs are effective although their application has been limited to segments of the interstate system in only a few States. These signs are more expensive; however, there is a large amount of implicit information conveyed by a logo. This highlights the problem that local businesses without a recognizable trademark are at a disadvantage.

Official business signs are signs for travel-related facilities which are standardized by State highway agencies but paid for by the affected businesses. Erected outside of the right-of-way, the signs are primarily for sites and attractions of interest to the travelling public. They are intended for areas where other types of signing (mainly outdoor advertising) are not available. Although official business signs are allowed in 46 States, their use is not widespread. They have been criticized as being too restrictive concerning the type and amount of information permitted to be displayed. Other problems stem from varying interpretations of standards resulting, in some cases, in signing for establishments which are predominately commercial in character.

The numerous remaining guide signs standardized in the MUTCD and found on the nations highways include direction and distance signs, rest area signs, scenic area signs, recreational and cultural interest area signs, and general information signs (political boundaries, stream names, landmarks, transportation terminals, etc.).

Commercial outdoor advertising, commonly referred to as billboards, can contribute to a motorist information system by displaying information of specific interest to unfamiliar motorists. Since all subject areas are permitted on outdoor advertising, the success of this depends upon the ability of travel related goods and services to obtain sign space. Due to this factor and the variation in the availability of sign sites, the effectiveness of outdoor advertising in transmitting motorist information consistently is a problem. An advantage of these signs is that they are privately owned and operated, although they are regulated by public agencies. Many people do feel, however, that these signs are unattractive.

Variable Message Signing, Limited Format - The inability of static signs to respond to changing situations is overcome by variable signing. Limited format variable signing is typified by a drum or flap-type sign. Several messages are inscribed on a drum-like device or on flaps which can be rotated to display any one of the messages at a time. As a communications medium, this category of variable signs is assumed to include all types in which a choice can be made of a limited number of predetermined messages.

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2 Federal Highway Administration, Options for Assuring Adequate Motorist Travel Information Systems U.S. Government Printing Office, May 1979, p. 9

Variable Message Signing, Unlimited Format - Unlimited Format is typified by the various kinds of matrix signs (vane, bulb, etc.). These have one feature in common, Except for the limitation of the size and number of elements in the matrix, message content is completely flexible. This category is assumed to include any type of variable signing with the degree of message flexibility characteristics of a matrix display.

Manned Information Centers - These provide information to unfamiliar motorists in heavily travelled areas of approximately 41 States. On the interstate system, these are generally operated by State agencies which are responsible for promotion. On other road types, local chambers of commerce usually provide the service. The information disseminated is generally accurate due to the personal nature of the system. A wide variety of information is available, normally in the form of printed materials.

Unmanned Information Centers - Normally located in some type of rest area, these consist of displays describing various services and attractions, and providing some directional guidance. Information which is not subject to frequent change is best displayed. The displays may be either publicly or privately funded. Although the initial cost is substantial to the operating agency, the maintenance costs are low.

Electronic Information Terminals - In recent years, systems have been developed for displaying relatively large quantities of information at electronic terminal stations. They have been installed primarily at some hotels and tourist attractions providing information or food, lodging, and attractions to persons generally unfamiliar with the area. The user can interact with terminals through a series of menus, selecting the information of interest. Substantial detail can be provided through such a system, and information can be updated periodically. For example, users could select restaurants by quisine, cost, or location and be provided with a detailed description of each.

Public Telephone Network - The public telephone network offers a very flexible medium for the transmittal of motorist information from consolidation centers to motorists. Excluding the use of mobile radiotelephones, (discussed later) the medium is restricted to providing information to fixed-points such as the home or office. It would therefore be a useful medium for satisfying pre-trip needs. Additionally, used at off-road locations, it may prove a useful means of satisfying some enroute information needs. As a two-way communications medium, the telephone could be used to query and obtain information from live operators at the consolidation centers. However, the staffing cost of a manned center capable of responding to a large segment of the public might not fit within the concept of a "low cost" system. Another approach would allow the motorist to dial up a recorded message much like the weather information available by telephone in many cities. A more sophisticated arrangement would allow the caller, after receiving a recorded instruction, to dial additional digits to select a desired category of information, such as weather, road conditions, or traffic. It is assumed that recordings would be changed as frequently as necessary to reflect changing conditions. A limitation on this media is the potential for "overload" in a high-demand situation, since the number of users at a given time is controlled by the number of incoming lines available.

Telephone With Computer - The use of a personal computer or a computer terminal to access a motorist information data base greatly enhances the telephone network as **a** transmittal medium for motorist information. Graphical information and printed text can be displayed on the CRT screen. The system can be made interactive allowing the computer to query the user concerning the specific information desired and then allowing the operator to respond with the proper keystrokes to obtain the information. The user would require a modem and appropriate computer equipment.

AM/FM Broadcasting - This is a transmittal medium currently in extensive use for the distribution of traffic information. For purposes of comparison with other media, it is assumed that motorist information is transmitted on the regular broadcast channel and shares this channel with other broadcast programming. By FCC regulation, AM and FM radio broadcasting services are restricted to aural uses. They are, however, suitable for transmitting both enroute and pre-trip information needs.

Automatic Radio Information (ARI) System - This is an adaptation of the FM broadcast medium for traffic information. A system by the same initials (ARI) has been in use in Europe for a number of years. It was introduced to the United-States in New York City, Long Island, and in nearby areas of New Jersey, New York, and Connecticut, by the Blaupunkt Division of the Robert Bosch Sales Corporation. ARI is now also operational in Philadelphia, Detroit, Southern California, and Toronto. Blaupunkt seeks to eventually cover a substantial portion of North America with the system.

ARI uses selected commercial FM stations to cover specific traffic zones. Each station broadcasts its usual mix of music, sports, news, etc. Every 15 minutes or so during the peak traffic hours, or whenever there is a traffic emergency, the station broadcasts a traffic bulletin. The feature that distinguishes an ARI station is the use of subcarrier control signals.

Each station uses two different control signals. One signal indicates the zone number of the traffic zone covered by the station. Another indicates the presence of a traffic message whenever such a message is being broadcast. A properly equipped receiver (sold by Blaupunkt and others licensed by Blaupunkt), when tuned to an ARI station, provides a LED display of the zone number. This lets the motorist know that he is tuned to the desired station. He may then listen to that station, listen to the tape deck, or turn down the volume and enjoy the silence. However, when there is a traffic message, the subcarrier control signal will disconnect the tape audio, if the tape deck is playing, and turn up the FM volume so that the message can be heard. At the end of the message, the receiver is restored to the same condition that existed before the message began.

Although it is possible to listen to ARI broadcasts in the home or office, the system is intended to satisfy enroute traffic information needs of motorists. The system will be able to cover rural as well as urban areas (provided there is fm station coverage). . However, it is expected that Blaupunkt will seek first to develop the system in large metropolitan areas; and, in fact, the focus to date has been on the New York and Philadelphia areas.

FM Broadcast, Subsidiary Channel - Subsidiary Communications Authorizations (SCAs) for FM broadcast stations have been granted by the FCC for many years for the transmittal of specialized program material. A typical example of SCA usage is that made by Muzak to transmit music to department stores and business establishments. Recent FCC deregulation has removed virtually all restrictions on SCA channels. This suggests the possibility of employing them for the transmittal of motorist information. One advantage of such a communications channel is that it could be made available full time without any interruption of the regular FM programming originating at the same station. Special receivers are required which by their nature are somewhat less sensitive than standard FM broadcast receivers. Effective coverage is therefore less than the main program channel. -However, good SCA channel coverage is normally obtainable over the primary coverage area of an FM station. SCAs would be suitable for either pre-trip or enroute information needs.

SCA receivers are commercially available in the range of $50 to $100. Electronics could be added to preempt broadcasting on the main channel to broadcast a traffic message on the SCA channel. It is likely that receivers could be made in quantity at a lower price and packaged with the standard AM/FM car radio.

FM Subsidiary Channel With Display - FM SCAs can be used for data as well as voice transmission. This suggests the use of a visual display (CRT, LED, or liquid crystal) perhaps in conjunction with an in-vehicular computer. Since FM SCA is a one-way medium, it would not be capable of supporting two-way interaction between a computer and a remote data base as can the public telephone network. It would, however, be capable of transmitting short digital codes to initiate much longer "canned" messages stored in the in-vehicular computer memory. (See discussion of radio paging with display.)

Television Broadcast - Like FM and AM, television stations broadcast traffic information. The information is essentially the same except that television is able to provide suitable visual displays, including such things as maps, graphs of average speeds on major arteries, and camera shots of actual traffic allowing the viewer to judge conditions for himself. Like the AM and FM broadcast media, motorist information distributed by broadcast television must be shared with other regular programming. Because television would be distracting to the driver, television as a transmittal medium is practical only for pre-trip planning.

Cable Television - Cable television has the same capabilities for distributing motorist information as broadcast television with one notable exception. The large number of cable channels available makes it feasible to dedicate a channel to full-time reporting of motorist information. Again, cable television is considered practical primarily for pre-trip planning, although it could be used at a fixed, off-road point under some circumstances.

Weather Radio - The National Weather Service currently broadcasts continuous weather information over a national network of stations. Each station is assigned one of seven VHF channels, ranging from 162.40 to 162.55 MHz. Receivers capable of tuning to these frequencies are required, but these are commercially available at less than $20. Receivers could be packaged together with the standard AM/FM car receiver at a relatively low marginal cost.

Knowledge of the weather may be of special interest in trip planning, particularly when there is a change of storms or severe winter weather. However, the concept of a specialized broadcast service of this type might be expanded to carry not only weather, but other information of general interest to the traveling public.

Citizen Band Radio (CB) - There are today approximately 30 million users of CB radios. It is a two-way system widely used on an informal basis to share information of interest to motorists. One of the 40 channels available (channel 9) has been designated by the FCC as an emergency channel, and this has greatly enhanced the value of CB as a motorist aid system. Its use has been further enhanced by the existence of numerous volunteer groups, some publicly sponsored, which monitor CB both for the purpose of collecting traffic information and rendering aid in emergencies. Radio Emergency Associated Citizens Team (REACT) which has nationwide representation, is typical of such organizations.

If CD is considered as a medium for the transmittal of motorist information from the consolidation center to the motorist, two modes of operation might be explored. In one, the consolidation center might guard one or more CB channels (other than channel 9) and respond to inquiries. The drawback of this mode of operation is the limited number of inquiries that could be handled. A mode of operation serving a greater number of people would be regular broadcasts of traffic information and other information of interest to motorists over designated and well-advertised channels.

For example, roadside signs might be erected reading "Tune to CB Channel 12 for traffic information, 6:30 - 9:30 AM and 4:00 - 6:30 PM." Two-way exchanges with the consolidation center might, in the latter case, be limited to reporting incidents rather than making inquiries. Only a receiver would be required to participate in such a system, although the user would not have the advantage of two-way communications for emergencies. A complete 40 channel CB set may be purchased for less than $100. Some car radios are available which have a CB receiving capability built in.

The major disadvantage of any system utilizing the CB frequencies as a transmittal medium is the lack of discipline and control in this radio service. By widely publicizing a plan to use certain channels at certain times for motorist information, it is probable that most CB operators would cooperate by not transmitting on those channels during the critical periods. However, there is no way of assuring that channels designated for such a purpose will remain free of interference.

Highway Advisory Radio - Travelers Information Stations (TIS) are licensed by the FCC to provide Highway Advisory Radio (HAR) service on 530 and 1610 kHz above and below the standard am broadcast band. Approximately 98 percent of the motor vehicles in the United States have AM radios, although not all will tune to the HAR frequencies. Transmitters are restricted in power, limiting the range of each HAR station to a relatively localized area. Motorists must be informed that they are approaching a transmitter by means of roadside signs and instructed to tune their radios to the appropriate frequency. Messages are usually short and continuously repeated so that each passing car gets the complete message. It is possible to update messages by remote means.

A substantial number of HAR stations have been installed since the service was first authorized by the&CC in 1977. Many of the systems *were* technically inferior, poorly maintained, and unimaginatively programmed. Many were programmed with messages recorded on endless magnetic tapes which were allowed to run until the accumulation of dirt on the heads and wear on the tape made the message barely decipherable. This has resulted in a great deal of bad publicity for the concept. In fact, the system is quite capable of high quality voice transmission and is in no way limited to the reproduction of tape recordings. Equipment reliability has been improved significantly with the use of digital voice storage. Some State departments of transportation, are now beginning to plan and install more sophisticated systems capable of providing up-to-the-minute traffic information. For example, the Illinois Department of Transportation is currently planning a multi-station system serving the Eisenhower Freeway in Chicago which will synthesize appropriate messages in accordance with instructions from a central traffic computer. The system will provide remote monitoring of the transmitters and centralized alarms for either failure of, or significant degradation of voice modulation.

A drawback of HAR is there are some areas of the United States in which one or the other of the two HAR frequencies (and sometimes both) cannot be used. The FCC Rules require that HAR stations not be installed within 15 km of the 5 millivolt/m contour of an adjacent channel AM broadcast station. Specifically, this prohibits the use of 530 kHz and 1610 kHz near stations broadcasting on 540 KHz or 1600 KHz, respectively.

Mobile Radiotelephone - The mobile radiotelephone provides access to the public telephone network from a motor vehicle. In this sense, radio-telephones are an extension of the public telephone system. They enable the enroute information needs of motorists to be delivered directly to moving vehicles.

Radiotelephones have been in limited use for many years operating in the VHF and UHF mobile radio frequency bands. This service has been offered by both the traditional "wireline" telephone companies and independent Radio Common Carriers (RCCs). More recently, the opening up of the Special Mobile Radio (SMR) service by the FCC has made a class of radiotelephone service in the 800 MHz band available to professional and business persons. Still more recently (beginning in 1982), the FCC has established the "domestic public cellular telecommunications service" which is expected to revolutionize the radiotelephone industry by enormously increasing capacity and quality of service. Altogether, 666 voice channels have been made available in the 800 MHz frequency band for cellular service. The concept of restricting the coverage of any group of frequencies to relatively small cells, combined with the capability of "hand-off" from cell to cell, allows the frequent reuse of the same frequency group in other cells within reasonable separation distances. The result is efficient use of a large number of channels which in turn maximizes the number of radiotelephone subscribers that can be accommodated.

Though expected to decline in time, the present cost of cellular service is still high. Initial installation is typically on the order of $1,500. Monthly and calling time update cost charges are applied after installation to cover the cost of service. Because of the cost, it is not expected that more than about 5 percent of motor vehicles will be equipped with some type of commercial radiotelephone by 1988.

Another drawback is coverage. The volume of business needed to make radio telephone operations profitable will tend to restrict such services to heavily populated urban areas. Significant coverage of rural areas is not expected to develop for many years.

Radiotelephone With Computer - Like the home telephone, the radiotelephone can link a computer with a remote data base. Assuming on-board computers with CRT displays in the cars of the future, the radiotelephone could serve as the means for receiving and visually displaying motorist information in the vehicle. Information could also be communicated aurally through voice synthesis technology. One advantage of the in-vehicular computer would be the ability to store data and display it at a time convenient to the user.

Radio Paging - Commercial radio paging services are widely available in the United States. In a conventional arrangement, the subscriber carries a miniature radio receiver with its own code assignment. When this particular code is broadcast from a central transmitter, the receiver emits a beeping sound, accounting for the application of the popular term “beeper” to paging receivers. The subscriber knows by pre-arrangement that he is to call a particular telephone number and receive a message. There are two improvements over this arrangement now available in many areas. One is the “talking beeper” which delivers an aural message immediately following the beeping signal. The other is a beeper with an alphanumeric display. This unit displays a short message following an alert (beep) signal, typically a telephone number to be called. Paging services are offered on all frequency bands (VHF low band, VH high band and UHF) and are available to the public mobile radio services. Recently, paging services have been authorized to operate in the 900 MHz band. Another recent development since the deregulation of FM-SCA has been the use of SCA channels for paging. Pagers are also used in the private radio services, often shared with two-way operations. A typical tone plus voice pager costs approximately $300.

A one-way motorist information radio service would have much in common with the paging services. Vehicles (or individuals) would carry the equivalent of a paging receiver. Motorist information messages would follow an alert tone in either aural or visual format. If visual, the receiver might be designed to interface with an in-vehicular CRT display. Each receiver would not require an individual code, but the selective coding capability might be used in other ways. For example, motorist information might be limited to selective areas by dividing the total coverage areas into zones and assigning each zone a unique code. The receiver would require a zone selection switch (actually a code selection switch). The motorist would select the desired zone and would receive only messages applicable to that zone. An “all zone” switch position might be added to allow the motorist a choice of hearing all messages broadcast.

Radio Paging With Display - As already noted, pagers are in use which provide a visual display of a short message. This might well be improved upon by tying the paging receiver in with an in-vehicular computer and CRT display. This could provide a means not only **of** displaying direct messages received via the paging channel, but frequently used “canned” messages stored in the computer memory. The advantage of the latter is that a short transmitted code can be used to initiate a much longer message, thereby making more efficient use of air time.

Identification of Possible Future Transmittal Media

This section attempts to identify and define transmittal media with possible application to the transmission of motorist information, but which still awaits further development and/or FCC rulemaking before they become available for use. In some cases, the media are still highly conceptual; they cannot be precisely defined either in terms of hardware specifications or applicable FCC regulations. However, no proposed medium is defined which has not been the subject of some degree of experimental or developmental activity.

Television Subsidiary Channel - The use of subchannel frequencies in the aural baseband of television stations is currently the subject of an inquiry by the FCC (Docket 21323, begun July 1, 1977). If the FCC-proposed rulemaking is finally approved, it will be permissible to transmit voice or data over subsidiary channels from a television transmitter in much the same manner now permitted with FM broadcast transmitters. Like the FM SCA, the subsidiary channels will be wholly independent of the main broadcast channel and can be completely dedicated (if need be) to use such as motorist information.

TV Subsidiary Channel with Display - TV SCAs will not transmit video but will be capable of transmitting digital data. They will therefore have the same capabilities as an FM SCA with display and radio paging with display.

Automatic Highway Advisory Radio (AHAR) - This is a concept which, for purposes of comparison with other media, will be defined as any use of FCC-licensed (or IRAC-authorized) frequencies to automatically provide information to motorists inside their vehicles. "Automatic" in this case means without any requirement for pre-notification of, or action on the part of the motorist. Such a system has been developed and demonstrated using frequencies in the 45 to 46 MHz band. The system was shown to be completely automatic, suitable for localized coverage, capable of limiting transmission to vehicles moving in one direction, and capable of limiting messages to specific priorities or categories selected by the motorist. The radio operation will automatically broadcast certain messages and then return the radio to its previous operating mode.

In a variation of this design, it has been shown that a message can be transmitted in a time-compressed burst of digital data which is stored in the receiver and used to regenerate the message in synthesized speech. The short transmission time makes it possible to use lower transmitter power since a moving vehicle needs less time within the coverage zone of the transmitter. Another possible use of digital data is the generation of visual displays.

Critical to a system of this kind is the availability of frequencies for its operation. New frequencies are notoriously difficult to find; and even when they are found and identified, the process of obtaining an allocation for a new service can be excruciatingly long. In a search for frequencies for the developmental system referenced, five frequencies (45.68, 45.72, 45.76, 45.80, and 45.84 MHz) were found to be the most promising. They are allocated to the highway maintenance radio service and are intended primarily for use by local governments. They are not favored by this user group because of skip interference and were, in fact, very lightly used at the time the frequency search 'was made (1981). On informal contact, members of the frequency committee of the American Association of State Highway and Transportation Officials (AASHTO) supported the suggestion that the use of these frequencies for highway advisory radio be permitted. Skip interference would be less of a problem in a use requiring the receiver to operate at relatively short ranges from a roadside transmitters.

There are other possible variations in design which would not affect the general concept. Included in this category are the experimental Carfax system on 500 kHz developed in the United Kingdom and Roadside Radio on 450 MHz developed in Japan as part of the Comprehensive Automobile Traffic Control System (CACS) project. However, any design will require a special receiver in the vehicle. Preferably, the receiver would be packaged together with the AM/FM car radio.

Induction/Low-power Radiation Media - There are electronic means other than the use of licensed frequencies that can be used to transmit information to moving vehicles. Magnetic induction and low-power radiation are both techniques which have been demonstrated. Typically, such techniques require a current-carrying wire or cable buried in the road surface or along side the road. The vehicle receiver may receive information through inductive coupling with the cable or from low-power radiation from the cable. The field strength produced by the wire or cable must be less than the limits (15 microvolts/m at 0.16 x wavelength) imposed by Part 15 of the FCC Rules.

An experimental system marketed under the name of "ATIS" (for Auto Travel Information System) has been demonstrated which used inductive coupling of direct audio from an elongated loop on the road surface to the vehicle. The General Motors Corporation built and demonstrated a similar system during 1963 to 1965 (dubbed "Hy-Com") which employed a modulated VLF carrier. A similar system was developed in France under the name "Protection of Automobilists and Aid to Circulation" (PAAC) which used frequencies in the 50 to 100 MHz range. All of these systems delivered aural messages to the motorist. All could conceivably transmit low speed digital data capable of being used to generate a visual or audible message display.

Mobile Satellite - For several years, NASA has been advocating the concept of a commercial satellite system supporting land mobile radio. A number of studies have been awarded to such contractors as General Electric, Jet Propulsion, ORI, Inc., ECO Systems International and Citibank covering technical feasibility, market analyses and financial analyses. In November 1982, NASA petitioned the FCC to initiate a rulemaking proceeding for the purpose of allocating frequencies for a mobile satellite system. So far, no notice of proposed rulemaking has been issued, despite the fact that two firms (the Mobile Satellite Corporation and Skylink Corporation) have filed for permits to construct commercial mobile satellite systems.

In the NASA proposal, a large satellite antenna would produce 87 spot beams in the 800 MHz band arranged to cover the United States in an overlapping pattern of "cells." Each spot beam would accommodate a substantial number of voice channels and would provide two-way communications between satellite and vehicles covered by the beam. Separate microwave links would connect the satellite to the public telephone network or to private communications centers.

It is **NASA's** contention that the mobile satellite system is needed to provide mobile telephone service to perhaps 60,000,000 persons in rural areas that will not be covered by cellular radio. Cost studies have indicated that cost per subscriber would be in line with those projected for cellular radio.

It is possible that the mobile satellite service could be used in urban areas as well. However, the large capital structures being put in place by the cellular systems in the urban areas mean they would strongly resist this. The institutional issue here seems to indicate that for the forseeable future this would be a primarily rural system, with potential for urban application at a later date.

Mobile Satellite With Computer - Tied in with an on-board computer, the mobile satellite telephone would provide essentially the same enhanced capabilities as the standard mobile radiotelephone. These are the ability to interact with and receive information data from a remote data base, and to display the information on a CRT screen.

Personal Radio Communications Service (PRCS) - PRCS is a proposal by General Electric Company that would permit virtually any citizen with a telephone to put an extension of that telephone in his car (or perhaps carry it on his person). It would be similar in operation to the popular cordless telephones except that the range of operation would be three to five miles from the home base rather than the 100- to 200-ft (30- to 60-m) limit of cordless phones. The range would be extendable to approximately 15 mi (24 km) through the use of "Extended Range Service" repeaters. Frequencies for the service would come from the 800 to 900 MHz band. The FCC has issued a Notice of Proposed Rulemaking (General Docket 83-26) requesting comments on the proposed establishment of the service. Cost of a PRCS base station and mobile unit is expected to be about $400. Cost of the optional Extended Range Service is expected to be about $10 per month. There would be no other recurring charges other than the subscriber's ordinary telephone rates.

Like the radiotelephone, PRCS can be regarded as an extension of the public telephone network. However, the 15 mi (24 km) limit on range from the base station places a limit on the usefulness of PRCS for the purpose of obtaining motorist information. PRCS could not be used, for example, on a long trip. Nonetheless, one group of motorists, commuters who work within 15 mi (24 km) of their homes, could benefit from PRCS. However, the FHWA and the National Highway Transportation Safety Administration (NHTSA) resonded to a Notice of Proposed Rulemaking sent out by the FCC. In their response, they suggested that PRCS users have the capability to access emergency numbers (such as 911) via any repeater station. In addition, they suggested that several channels be available over which motorist information could be received.

PRCS With Computer - Tied in with an on-board computer and operating within range of its home telephone, the PRCS mobile telephone would provide essentially the same enhanced capabilities as the standard mobile radiotelephone. These are the ability to interact with and receive information from a remote data base, and to display the information on a CRT screen.

Direct Broadcast Satellite (DBS) - The technology of TV broadcasting via satellite is rapidly advancing, and several proposals are before the FCC for licensing that would bring the cost savings down considerably from the present. Most of the proposed systems would cover the U.S. with up to four zones, generally corresponding to the time zones. The reception would be only to subscribers, and rural as well as urban areas would be well-covered. The size of the zones would limit the applicability for motorist information use since localizing the information would be difficult.

Since the DBS requires a disk antenna signal unscrambler and other equipment, it will be suitable only for application at fixed locations, either pretrip or enroute.

Transmittal Media Summary and Potential Applications

Table 6 lists all the transmittal media discussed in the preceding section. The table also shows the suitability of each medium for a number of possible applications. One of these concerns motorists at fixed locations and in moving vehicles. Media such as Cable TV are suitable only for providing information to fixed locations. Roadside signs of all types are suitable for providing information to motorists in their vehicles. Some media, such as AM/FM broadcasting, are applicable to either situation.

Another media characteristic is the applicability to aural or visual presentation of information. Roadside signs use a visual format. AM/FM radio uses an aural presentation. Television uses both. The telephone network would ordinarily provide information in an aural format. However, used as a means of interconnecting a computer with a remote data source, it can also provide a CRT display of received information.

A third possible application is to urban versus rural areas. For economic reasons, most existing media have been concentrated in urban areas. All the media listed would be suitable for use in urban areas with the exception of mobile satellite. Although not technically limited to rural areas, it is a stipulation in the NASA proposal that the mobile satellite be prohibited from serving urban areas in order not to compete with cellular radio. The extent to which rural areas are currently served by existing media is very much a function of the remoteness of the area. Most areas in the United States are covered by one or more AM or FM broadcast stations. Areas outside of cities and towns of moderate size are not so likely to enjoy a mobile telephone or paging service.

The type of information (dynamic, semi-dynamic, static) addressed by each medium is also indicated in Table 6. The table indicates the primary type or types of information toward which the medium would be oriented. For example, variable message signs are oriented primarily toward dynamic information. Although they could be applied to semi-dynamic and even static information, this is not their primary orientation.

EVALUATION OF CURRENT SYSTEMS VS. MOTORIST NEEDS

Prior to examining alternatives for improving the motorist information system it is necessary to determine the effectiveness of existing systems in meeting the

Table 6. Summary of Motorist information Transmittal Media and Potential Applications

Medium	Motorist Location		Presentation		Area of Coverage		Type of Information		
	Fixed	Vehicle	Aural	Visual	Rural	Urban	Dynamic	Semi-Dyn.	Static
Daily newspaper	x	x		x	x	x		x	
Brochures/maps	x	x		x	x	x		x	x
Static signing		x		x	x	x			x
Var. Signing. Ltd format		x		x	x	x	x		
Var. Signing, unltd format		x		x	x	x	x		
Unmanned Information Centers	x		x	x	x	x		x	
Manned Information Centers	x		x	x	x	x		x	
Information Terminals	x			x	x	x		x	
Public telephone	x		x		x	x	x	x	x
Telephone with computer	x		x	x	x	x	x	x	
AM/ F.M broadcast	x	x	x		(1)	x	x	x	
ARI		x	x		(1)	x	x		
F.M SCA		x	x		(1)	x	x		
FM SCA with display	x	x		x	(1)	x	x		
TV broadcast	x		x	x	(1)	x	x		
Cable TV	x		x	x		x	x		
Weather Radio	x	x	x		x	x	x		
CB	x	x	x		(2)	x	x	x	
HAR/TIS	x	x	x		x	x	x	x	
Radiotelephone		x	x		(3)	x	x	x	
Radiotelephone with computer		x		x	(3)	x	x	x	
Radio paging	x	x	x			x	x	x	
Radio paging with display	x	x		x		x	x	x	
TV SCA	x	x	x		(1)	x	x		
TV SCA with display	x	x		x	(1)	x	x		
AHAR		x	x	x	x	x	x	x	
Induction/L.P. Rad		x	x		x	x	x	x	
Mobile satellite		x	x		x	(4)	x	x	
Mobile satellite with computer		x		x	x	(4)	x	x	
PRCS		x	x		x	x	x	x	
PRCS with computer		x		x	x	x	x	x	
DBS	x		x	x	x	x	x		

Notes:

(1) Suitable in rural areas only to the extent that broadcast coverage of rural areas is provided.

(2) CB as a means of reaching motorist from a consolidation center would be limited in rural areas because of the limited range of CB.

(3) Radio telephone service are often not available in rural areas.

(4) In the NASA proposal, use of mobile satellite service would be restricted by regulation to rural areas.

information needs identified in Chapter 2. Particular attention can then be given to ways of improving systems which address those needs, particularly the high priority needs.

Figure 16 presents a generalized graphical evaluation of the degree to which existing systems fulfill the information needs of motorists. The needs are organized in the three basic categories while the systems are presented in a structure similar to that previously shown in Figures 14 and 15. Future systems are not shown in the table.

In the figure, a relatively simply rating scheme is used. The following symbols indicate the level of fulfillment of each need from the particular MIS:

= High

= Medium

= Low

Blank indicates that the need is not addressed by the system.

These are obviously subjective, based on the project team's judgement and information from existing literature.

The general ratings reflect several aspects of how well existing systems are meeting motorist needs. These reports primarily include the penetration of the system into the motoring community and the quality and usefulness of the information provided.

In developing enhanced information systems, a solution for an identified current deficiency may involve increasing the availability of certain existing devices or systems. The purpose of this discussion is to evaluate the current fulfillment of information needs and not to evaluate the information systems themselves. An evaluation of the systems is presented in Chapter 4.

Table 7 supplements Figure 16 and summarizes main points concerning fulfillment of motorist needs as related to the availability of existing systems and the urban or rural environment.

Findings

The comparison between the motorist needs and current motorist information systems provides for a variety of findings which will have applicability for future tasks. Several of the more pertinent are discussed in this section.

Defining where there are the most deficiencies in providing the above information would indicate where the most attention should be placed in improving MIS's. Although all of the information needs are addressed by at least two existing

Motorist Needs	Info Center Displays	Off Road Terminals	Printed Material	TV	Variable Message Signs	Static Signs	Telephone Based	Standard Comm. Radio	Preemptive Radio	NOAA Weather Radio	Highway Advisory Radio	CB Radio	Manned Info Center
<u>Dynamic</u>													
Temporary roadway conditions		○			○		○	○	○	○	○	○	
Delay causing incidents				○	○			◒	◒			◒	
Weather information		○	◒	◒	○		◒	◒		◒			◒
<u>Semidynamic</u>													
Vehicle services information	○		○			◒	○					○	○
Roadway route characteristics	○		◒										◒
Overnight lodging information	○		◒			○	◒					○	○
Parking at major generators	○		○		◒	○	○				◒		○
Restaurant information	○		◒			○	○					○	○
<u>Static</u>													
Permanent roadway conditions						●							
How to contact emergency services	○		○			◒	○					○	○
Non-services locational information	○	○				◒						○	◒
Speed limits						●							
Location of nearest telephone	○		○			◒							◒
Location/distance to rest area	○		◒			●							◒
Toll information	○		○			◒						○	◒

Level of fulfillment: ● High
◒ Medium
○ Low

Blank indicates system does not address need

Comparison of Motorists Needs and Current Information Systems

Figure 16

Table 7. Summary of Conclusions Regarding Existing System's Fulfillment of Motorist Needs

Motorist Needs (Priority)	Analysis Summary
<u>Dynamic Information</u>	
Temporary Roadway Conditions (A)	Current methods such as VMS are useful; but they are used infrequently and primarily only in urban areas. Commercial radio systems are becoming mpre developed. ARI provides good information, but has limited capabilities and is valuable primarily to familiar motorists. Timeliness and quality of reports remain a concern.
Delay-Causing Incidents (A)	This need is well met for familiar motorists in urban areas and in peak periods through use of commercial radio and ARI. A CB radio can be used in urban areas because of the number of possible respondents. VMS is used primarily in recurring delay locations. This need has a more difficult/lower fulfillment for longer-distance, unfamiliar motorists, especially in rural areas.
Weather Information (B)	This has good fulfillment for general/local conditions, lower fulfillment for longer-distance motorist looking for conditions along route. Weather radio gives good information, but requires special equipment. HAR at rest areas appears to offer good potential but is just beginning to be used.
<u>Semidynamic Information</u>	
Vehicle Services (B)	First level needs are well fulfilled if logo signs are available. In rural areas, billboards and outdoor signs are valuable, but are not always found except on main roads, and reliability of the information is poor. Second level needs, especially for maintenance services, have very low fulfillment.
Overnight Lodging (C)	Information, primarily in printed form, must be obtained pretrip. Billboards or visibility from the roadway are the primary on-road means, but they are not always present. This leads to poor fulfillment for second level information without guides. There is little comprehensive information; available information is primarily slanted toward certain franchises.

Table 7. Summary of Conclusions Regarding Existing System's Fulfillment of Motorist Needs (Continued)

Motorist Needs (Priority)	Analysis Summary
Speed Limits (C)	Signs are the predominant current method. They provide good fulfillment for normal conditions, but do not respond to changing conditions, need for variable advisory speeds or catch the attention of motorist well. VMS is effective for this, but is infrequently found.
Parking at Major Generator (C)	The need is fulfilled well by HAR but it is infrequently found, and is often poorly maintained. Printed information is available pretrip and off-road, but not on dynamic conditions. This need is not otherwise fulfilled.
Restaurant (C)	There is low on-road fulfillment of this need through any system. Logo signs are the best current method. Some billboards and static signs are present but are not found consistently and are infrequently used in urban areas. Pretrip guides and information centers provide some information, but it is not comprehensive.
<u>Static Information</u>	
Non-Services Location Information (C)	Signs and billboards are used for major recreational locations. Good fulfillment is provided for some destinations such as colleges and major government areas. Maps can be used on-road, but many locations are not shown. CB radio can provide some fulfillment, depending on knowledge of respondent. Fulfillment of this need depends largely on the particular destination.
Permanent Roadway Conditions (A)	Signs are the primary means currently used, and satisfies most needs. Visibility can be a problem and often the driver has little "expectation" of coming conditions. HAR could be used, but most drivers do not tune in their radios.
How to Contact Emergency Services (B)	There is little on-road fulfillment unless the direction sign near an emergency facility (hospitals) is seen (primarily on interstates). Off-road, drivers can use the telephone, so this is related to other needs concerning rest areas, telephones. Standardization of 911 number is improving ability to contact emergency services in areas unfamiliar to motorist.
Location of Telephone (C)	This special need is often poorly fulfilled unless phone is on-road in rest area or information center. Very little information available concerning distance to next phone or off-road locations. Telephones provide fulfillment of several other needs.

Table 7. Summary of Conclusions Regarding Existing System's Fulfillment of Motorist Needs (Continued)

Motorist Needs (Priority)	Analysis Summary
Location of Rest Area (c)	"Distance to next rest area" signs fulfill need, but are often not found (primarily found on interstates and toll roads). They can sometimes be found in pretrip information (guides, tour services, etc.) and at information centers.
Toll Information (C)	Signs are currently the only on-road information source. They provide partial fulfillment, but the driver must react to correct lanes while trying to maneuver in traffic. Some off-road and pretrip sources provide information on the amount of the toll and the location and configuration of the toll plazas.

systems, there are still deficiencies in how the needs are being met. Some of the systems, such as HAR, are too infrequent to have a major impact on the need, while other systems are functionally inadequate to meet the need,

In summary, some of the more significant motorist needs which are not adequately met by current systems are:

- Temporary roadway conditions.
- Delay-causing incidents.
- Location of vehicle services.
- Overnight lodging availability.
- Availability/cost of parking and other information on major generators.
- Location of restaurant (plus more detailed information on price range, etc.).
- Non-services locational information.

As indicated above, the only need for dynamic information which is currently well met is weather information. It has characteristically been difficult to provide the level of detail necessary on information such as temporary roadway conditions and delay-causing incidents within the time frame required to be very useful to the motorist.

In the area of semidynamic information, the needs which are not adequately met are most noticed by the unfamiliar driver. This would usually mean the longer distance driver but could also mean the local driver who is unfamiliar with a certain geographic area in a Iarger urban area. The motorist information system concept developed in this study must particularly address the above needs. In comparison with the dynamic and semi-dynamic information needs, static information needs are relatively well met. Because the information changes only rarely, signs are well-suited to the provision of static information. The low cost of signs has contributed to the more widespread implementation of signing systems.

INSTITUTIONAL CONSTRAINTS AND ISSUES

In any discussion of current and future motorist information systems, the topic of institutional constraints and issues must be included. The communications systems in the U.S. exist in a complex regulatory environment that involves both government and private industry. This section discusses a variety of these issues which will have to be taken into account throughout the future tasks.

The issues discussed include:

- FCC regulations.

- Frequency availability, allocation, and assignment.
- State and local government roles in communication regulation.
- Sources of funding for motorist information systems.
- Cable television channel availability.
- Basis for State agency involvement.
- Effects of recent changes in the telephone industry.
- Potential liability of information providers.

Each of these are included as separate topics in the following section.

FCC Regulations

Frequency usage within the United States and its territories is regulated by the Federal Government. The United States is a member of the International Telecommunications Union (ITU), participates in its activities, and is bound by treaty to act within the regulations established by the ITU. However, it is the United States Government that actually assigns and regulates the use of radio frequencies within its own boundaries, air space, and coastal waters.

Frequency usage by agencies of the Federal Government, including the military services, is administered by the National Telecommunications and Information Agency (NTIA) within the Department of Commerce. Frequency use by all others, including State and local governments, private organizations and individuals, is administered by the Federal Communications Commission (FCC). Both NTIA and FCC work from a National Table of Frequency Allocations which appears in Part 2 of the FCC "Rules and Regulations," and in Chapter 4 of the NTIA "Manual of Regulations and Procedures for Federal Radio Frequency Management." Frequencies are allocated as "government" and "nongovernment" depending on whether they are intended for use by Federal Government agencies or by other than Federal Government agencies. In some cases, frequency bands are shared between the two. Allocations as between government and nongovernment can be changed by NTIA/FCC agreement.

The Federal Communicatons Commission is composed of seven Commissioners, appointed by the President and confirmed by Congress, each for a seven-year term. In its day-to-day operations, the Commission is assisted by a large staff of experts. The staff is organized into 11 principal units, which are:

1. Office of the Managing Director
2. Office of Plans and Policy
3. Office of Public Affairs

4. Review Board
5. Office of Administrative Law Judges
6. Office of General Counsel
7. Office of Science and Technology
8. Mass Media Bureau
9. Field Operations Bureau
10. Private Radio Bureau
11. Common Carrier Bureau

The day-to-day work of processing applications and enforcing the regulations is performed primarily by the four bureaus. The Mass Media Bureau (formed from the old Broadcast and Cable Television Bureaus) is responsible for regulation of the radio and television industry, including cable television. The private Radio Bureau regulates the use of radio by persons, businesses, State and local governments, and other organizations licensed to operate their own communications systems for their own use as an adjunct of their primary business. This bureau would be concerned with transmission of low cost motorist information over any radio facility licensed to a State or local government agency or to a private (noncommon carrier) organization.

The Common Carrier Bureau regulates the services, facilities, rates, and practices of entities which furnish interstate communications services for hire. This includes communications by wire, radio, cable, or satellite. It regulates all common carrier frequency use and transmitting stations whether or not such stations and frequencies are in the strict sense used for interstate communications or not. A low cost motorist information system might use common carrier facilities such as telephone lines, or mobile radiotelephones. Such use is likely to be confined to existing services for which established rates and tariffs would be charged.

The Field Operations Bureau is principally concerned with enforcement activities including inspection, investigation, and monitoring. A significant part of its activity is devoted to identifying and suppressing sources of interference to authorized radio services.

In the granting of radio licenses, the FCC controls not only the assignment of frequencies, but many details of use. These include locations, radiated powers, antenna heights and gain characteristics, bandwidths, modulation, frequency stability and other technical features. Regulation of use and message content varies with the type of service. There are many rules pertaining to the content of commercial broadcast programs and few pertaining to common carriers since common carriers have little control over message content. Messages transmitted by licensees in the private radio services must generally be related to the business or function of the licensee.

Frequency Availability, Allocation, and Assignment

The FCC has traditionally allocated frequencies by service. For example, specific frequency bands are allocated to the Broadcast Service for AM, FM, and television broadcasting. Over the years many such services have been recognized, eligibility established, and frequencies allocated for the use of each. Services for which State and local governments are eligible include the Police Radio Service, Fire Radio Service, Local Government Radio Service, Highway Maintenance Radio Service, Forestry-Conversation Radio Service and others. Commercial enterprises may be eligible in the Power Radio Service, Petroleum Radio Service, Business-Radio Service, Manufacturers Radio Service, Railroad Radio Service, Taxicab Radio Service or others, depending on the nature of the applicants business. Amateur radio operators are eligible in the Amateur Radio Service. Radio common carriers are licensed in the Public Mobile Radio Service. Any citizen at least 18 years of age may be licensed in the General Mobile Radio Service. No license at all is required in the Citizens Band Radio Service (CB).

In most radio service, frequencies are assigned to an applicant on an exclusive basis. That is, frequency is assigned to only one applicant in a given area. That frequency is available to others, but only in areas sufficiently far away to avoid the likelihood of interference. (Some exceptions to this are the Amateur Radio Service, where licensees may use any of the amateur frequencies, and the Business and General Mobile Radio Services, where licensees may be required to share frequencies with others in the same general area). Over the years, most frequencies allocated to the various radio services have been assigned. This is particularly true in heavily populated areas. As a result, new applicants often find it difficult to obtain the frequencies they need. This has been especially true in the mobile radio services, which seem to be chronically short of frequencies. To relieve congestion in the mobile radio services, the FCC acted to permit sharing television channels 14 through 20 in the 13 largest metropolitan areas. Later, television channels 70 through 83 (806 - 890 MHz) were re-allocated to the mobile radio services. This “800 MHz band” is now being rapidly filled with cellular, trunked and conventional mobile radio systems.

Two distinct types of communications may possibly be required in motorist information systems. One is point-to-point, which might be needed to bring information from the collection points to a central point for processing, and/or to distribute the processed information to fixed- transmitter sites or other points of usage. It is likely that this kind of communications can be handled by existing common carrier or by private microwave licensed in one of the presently authorized radio services.

The other type of communications, more difficult to achieve, is the distribution of information to moving vehicles. Means widely used to date are the AM and FM broadcast channels. No special license is needed to distribute motorist information as part of the regular program material of broadcast stations. Further, because of recent deregulation actions by the FCC, it appears that no special license **or** authorization would be needed to use a “subsidiary carrier authorization” (SCA) to distribute motorist information. The use of an SCA subcarrier could provide full time availability of broadcast stations for the distribution of motorist information without interrupting **or** displacing regular program material.

Another source of frequencies available to a low cost motorist information system are those allocated to the unrestricted services, specifically, the Citizens Band Radio service and the General Mobile Radio Service. No license is required for CB. Licenses in the GMRS may be issued to any person aged 18 or older, as well as to state and local governments and private institutions. The problem with these and any other shared service is that the user has no exclusive right to the assigned frequencies. The motorist must therefore accept any interference from other authorized users of the same frequencies. However, the good acceptance by the CB community of channel 9 as the emergency channel indicates that other channels might be designated for the purposes of sharing or disseminating motorist information. Such a use of a channel would need to be well-publicized for there to be a reasonable degree-of compliance with the intent of the channel.

Another plan would be to seek exclusive frequency assignments in an existing service such as the Local Government Radio Service or the Highway Maintenance Radio Service. To do this, the applicant must show that his application complies with rules pertaining to the service in which he is applying. In the above examples, the application would have to show that the applicant is an agency of a State or local government and that the proposed operation of the motorist information system is a legitimate function of that agency. Further, as in all such applications, the applicant would have to show by coordination with other users in the vicinity, or by an engineering study, that the frequencies applied for would not result in interference to prior licensees. Whether such an application would be accepted would depend on the case made by the applicant and the FCC's response to it. Minor deviations from the rules might be accepted on a waiver. [Major deviations would surely result in rejection of the application. A major drawback of this approach would be the need for motorists to install special receivers either in conjunction with or apart from the standard AM/FM radios. Associated with this is the problem of creating the inertia to initiate the service. Motorist will not likely purchase the receiver unless a system is broadcasting information, and it is difficult to convince a public agency to initiate a service to motorists without receivers. This is a common problem for any radio-based service in which motorists would need to purchase additional receiving capability (e.g., AHAR or FM SCA channels).

If other approaches prove unsatisfactory, a possible last resort is to petition the FCC for the establishment of a new service. This is a process that may take months or years with no assurance of a successful outcome. To be successful, such a petition must contain not only the details of the proposed new service and the frequencies to be allocated to it, but a convincing argument as to why the new service is needed. The Commission will accept comments from others for and against the petition, and if it feels more information is needed, may issue a formal Notice of Inquiry. If the Commission determines that the proposed new service has merit, it may then issue a Notice of Proposed Rule Making presenting the arguments, detailing the exact changes in the FCC Rules proposed, and inviting further comment. Eventually, the requested rule changes will be issued or the whole proceeding will be dropped without further action.

State and Local Government Roles in Communications Regulations

The Communications Act of 1934, which establishes the FCC, provides that: "...nothing in this Act shall be construed to apply or give the commission jurisdiction with respect to (1) charges, classifications, practices, services, facilities, or regulations for or in connection with intrastate communication service by wire or radio..." With the exception of the assignment of frequencies and licensing of radio stations, States are free to regulate intrastate communication services. This authority is normally excercised through the State utility commissions and is usually limited to the services and rates of common carriers. However, the regulations of other State agencies may impact communication facilities. Most notorious of these are the zoning boards which can enforce restrictions on such things as locations and antenna heights of radio stations. Another example is public health agencies which in some States have successfully limited the placement and/or radiated power of stations on the grounds of radiological hazards to the general public.

Sources of Funding

Funding for motorist information systems might come from the Federal Government, State government, local government, nonprofit institutions, commercial sources, and the motorist, or various combinations of these. A discussion of each of these follows.

The Federal Government, particularly the Department of Transportation through the Federal Highway Administration and National Highway Safety Administration, is a possible source of funding for the development and initial deployment of a low-cost motorist information system. This type of activity would be in accordance with the Highway Safety Act of 1966 in which the secretary of transportation is required to adopt uniform standards for "detection and correction of high or potentially high accident locations and emergency services," However, it would not be the function of the Federal Government to fund the maintenance and day-to-day operation of such systems once established on an on-going basis.

Highway safety and control of traffic are long-standing responsibilities of State and local governments. To the extent that a motorist information system proves useful in the discharge of these responsibilities; state and local governments are likely sources of funding. This is particularly true of the operation and maintenance of fixed facilities for processing and transmission of information. Certain programs of the Federal Government provide funding for specific motorist information activities. For example, equipment for a highway advisory radio station may be purchased as a part of a 4R construction project using federal funds.

Non-profit institutions may include such organizations as local chambers of commerce, travel councils and REACT. These are candidates not so much for direct funding as for volunteer services and provision of certain types of printed or verbal information.

Commercial sources of funding would be applicable to certain elements of the system which are either operated for profit or sponsored by advertisers. Several arrangements are possible, including:

- Assessment of user charges to completely cover the costs of operation. Examples of this would be the charging of a fee for each call to a traffic information phone number or charging of connect time to a computer data base.

- Recovering cost of providing information through advertising. This is commonly done by the private traffic information services, who derive income from advertisers whose ads are aired along with traffic broadcasts. Telephone traffic information could also be offered the same way.

- Recovering cost of providing information through the sale of devices used to provide the information. This approach is being used by the ARI system and would be employed in most ventures involving in-vehicular computers. Some companies selling mobile telephones have provided information services for exclusive use of their customers.

- Public agencies contracting with commercial firms to perform specific services. Provision of information and vending services at rest areas is often done in this way.

- Public agencies subsidizing commercial services where providing the information is in the public interest but the operation could not be sustained on its own.

- Public agencies providing seed money for certain commercial operations where the initial risks are greater than a commercial service would be willing to bear, but where providing the information is in the public interest.

Several philosophical questions arise with the alternatives presented above. One involves the extent to which the user should be expected to pay for the information received. Another is the extent to which the government has an obligation to provide and fund motorist information. It could reasonably be argued that the user should be expected to pay for any information beyond that "minimum essential information" assumed to be provided by governmental agencies. Allowing commercial services to provide all information beyond this minimum level would assure that this would be the case. This would also clarify the governmental role in the funding of motorist information. The most difficult question is, however, how to provide a clear definition of "minimum necessary information."

Cable Television Channel Availability

The cable television franchises granted by most communities typically require the cable company to provide a number of "public service" channels free to the community. In some cases, cities are having difficulty finding uses for these channels. Motorist information provided by the local government or a non-profit institution would probably meet the requirements for use of a public service channel under most franchise agreements. Even if provided for profit, it might still be feasible to lease a channel from the cable company. Cable television would be an ideal way of providing continuous motorist information programming in the home or office, to be consulted before leaving for any trip by motor vehicle.

Basis for State Agency Involvement

State governments build and maintain highways, often with substantial Federal assistance. States also assume responsibility for highway safety. In many States, these and other functions are consolidated in departments of transportation. All States have some agency with the designated responsibility of administering and directing the efforts to comply with the highway safety standards established by the United States Congress in the Highway Safety Act of 1966. Basically, this function involves working with the traffic safety agencies, local political subdivisions, and others in the State in the development and funding of traffic safety improvement projects.

State governments are also engaged in providing facilities and information for the convenience of motorists beyond that required for safety. Highway signs giving direction and distance are a case in point. So is the provision of conveniences, road maps, and tourist brochures at rest stops along the interstate highways. Motorist information systems can readily be interpreted as an extension of services already provided by State government agencies.

This was, in fact, the interpretation of the Task Force to Restudy Directional and Informational Signing in their 1979 report. The task force noted increasing acceptance of the view that "overall responsibility for providing a safe, efficient, convenient, and economical highway system encompasses the specific responsibility for assuring that motorists using that system have adequate and timely information regarding goods, services, and facilities essential to travel, and recreational and travel-related interests that may be the purposes of travel." Reference was made in Chapter 1 to the concept of DOT responsibility for at least the minimum essential information needed while traveling. The Task Force report indicates the legal authority for undertaking various aspects of the provision of motorist information by public and private agencies.

Another important institutional issue is the level of coordination and cooperation needed among public agencies. It has been noted, in some past situations of local emergency, that an inadequate system of communication and a lack of understanding of certain agency responsibilities and roles exist. Communication at the local agency level is vital for dealing not only with these major emergencies but also with the more routine events such as major traffic incidents. Particular attention needs to be paid to the role of police agencies in the motorist information system. They are often charged with on-scene responsibility for traffic incidents and thus possess much of the information which is needed to be communicated to the public in such instances. However, the provision of traffic information is not perceived as one of their primary responsibilities. Means of improving the communication between police and other public and private agencies (particulary with DOT's and the media) need to be developed; and, in some cases, their role in providing motorist information needs to be clarified.

Effects of Recent Changes in the Telephone Industry

The breakup of the Bell System should have little effect on the leasing of private lines for information exchange. As before, these will be leased from the local operating companies except in the rare cases where such lines connect points in separate States. However, two factors will affect the use of the public telephone system as a primary means of distributing motorist information. The first is the consent decree governing the breakup of AT&T which prohibits Bell operating companies from providing information services. The intent is to avoid a conflict of interest in which the telephone company both provides facilities and competes with others requiring the use of those facilities. This may be interpreted to mean that telephone companies cannot themselves supply motorist information as they now provide time and weather information. This would not, of course, prevent others from using the telephone system to distribute motorist information.

The second factor is the rapid development of cellular radio telephones that is currently taking place. Within a few years, it is expected that a substantial number of the motoring public will have telephones in their cars. **A** dial-up motorist information system would make information available to people not only in their homes, offices, and roadside telephone booths, but directly in their vehicles.

Potential Liability of Information Providers

The question of the liability of information providers for either providing misinformation or failing to provide information when there is a presumed obligation to provide it (e.g., warning motorists of a hazardous condition) is one that may merit future study by legal experts. In the past, governments have always been more or less responsible for the consequences of negligence, malfeasance, etc., on the part of their agents. This would probably include negligence in the operation of a motorist information system. If so, this may amount to no more than the normal risks of running a government and may be completely acceptable. The same may be true of commercial interests involved in a motorist information system. Any commercial enterprise accepts some liability. The degree of potential liability would depend on the type of information being provided. Failure to provide expected information on safety hazard could certainly involve liability, while the failure to provide services or directional information would probably involve minimal liability since the consequences are not severe.

One problem in this regard may be with the participation of volunteer and non-profit groups. To hold such groups liable for acts performed in good faith (no malicious or criminal intent) would be to discourage their participation. One possible solution is to operate the motorist information system under the auspices and control of a State or local government. That government might then use, or permit the use of information provided by volunteer organizations, but would agree to hold the organizations harmless should any claims of damage result from the use of such information.

4. DEVELOPMENT AND EVALUATION OF ALTERNATIVE MOTORIST INFORMATION SYSTEM CONCEPTS

OVERVIEW

The purpose of this chapter is to develop and evaluate overall concepts for providing motorist information. Whereas Chapter 3 discussed the status of existing systems and some evolving technologies, Chapter 4 projects what methods, technologies and institutional arrangements will be necessary within the next 20 years to more completely meet the needs of the motorist. In other words,-the question is being asked, "Where do we go from here?"

This introductory section presents an overview of the process for developing and evaluating motorist information system alternatives. It presents the guidelines used in the development of alternative MIS concepts, and describes the approach used in the evaluation of each concept. Other sections in this chapter are as follows:

- Identification and Evaluation of Alternative MIS Components.
- Integration of System Components into Comprehensive MIS Packages.

Development Of Alternative MIS Concepts

One of the primary purposes for this research study is to provide guidance for FHWA, other government agencies and private enterprise in how to more effectively provide information to the highway user. Technology has been rapidly advancing in the communications arena, and these advances are likely to impact on and provide new opportunities for providing both pre-trip and enroute motorist information. However, it is as yet unclear how to best take advantage of or even keep pace with these evolving technologies. Whereas new methods of communication enable new ways of transmitting and receiving information, the support structure for providing appropriate, accurate and timely information is lagging considerably behind.

The focus of this chapter is on identifying ways in which motorist information systems might be improved. Originally, it was thought that it would be possible to approach the development of alternatives in the same way as a typical engineering study, with perhaps three or four major alternatives, each of which would be evaluated and from which one would be selected. During the course of the study, however, it was found that the assessment of motorist information alternatives did not lend itself to this approach. Rather, a set of generic information systems was developed, oriented around the information needs developed in Chapter 2. The generic systems were derived by evaluating the individual data collection, consolidation and transmittal components and including into each concept those components which were rated as most effective.

Later in this chapter, four basic motorist information system concepts are described which address the three types of information. The four concepts are:

- Concept for dynamic information in medium to large urban areas.

- Concept for dynamic information in small urban and rural areas.
- Concept for semi-dynamic information.
- Concept for static information.

Each of the concepts are specified in terms of their data collection, consolidation and transmittal components. In certain cases, a single consolidation center is recommended. In other cases, multiple consolidation centers are more appropriate. For each concept, there are muitiple data collection and transmittal methods which can be used, each of which are necessary and legitimate methods. For example, the collection of data on traffic conditions for traffic reports in urban areas requires a multi-faceted approach using several different sources of information, and a number of transmittal methods should be used in parallel to disseminate the information. The most appropriate combination of sources and transmittal methods depends on the geographic, institutional, economic and traffic characteristics of each particular urban area.

The four concepts proposed above are not simple alternatives but are overall conceptual systems designed to address different motorist information requirements. It was found that the most appropriate approach to the development of alternatives was to identify alternatives for each of the three major functional components (data collection, consolidation, and transmittal) for each concept. The three components could then be evaluated independently from one another. For example, in the concept for dynamic information in urban areas, data collection components could be evaluated among themselves, consolidation center alternatives could be evaluated among themselves, and transmittal methods could be evaluated among themselves. From the results of these evaluations, the best data collection, consolidation, and transmittal components could be selected and packaged together into the recommended concept for dynamic information in urban areas. Thus, the decision of which data collection options to include in the overall concept is, with few exceptions, independent of which consolidation and transmittal components are included. In other words, a decision as to which data collection alternatives to include can be made without knowing how the information is to be transmitted to the motorists.

Taking the dynamic information concept as an example, the following alternatives were evaluated:

- Seventeen data collection alternatives, of which eleven were included in the final concept.
- Five consolidation center alternatives of which one was recommended for inclusion into the final concept.
- Twenty-four transmittal alternatives, of which ten were included in the final concept.

Similar analyses were conducted for the other three concepts.

The resulting concepts are generic in nature, recognizing that the exact data collection and transmittal methods will vary from city to city. In a city with heavy emphasis on surveillance and control systems, for example, data would not necessarily be collected in the same way that it would in a city that had no surveillance and control. The concepts are intended to be flexible, with specific data collection, consolidation and transmittal components applied based on local conditions. The next logical question is "How do you know which components are most appropriate for a particular local area?" This will become more apparent as the concepts are developed in this chapter, but is more specifically addressed in the case study in Appendix I3 (bound in a separate document). Details of how the individual MIS components were evaluated are presented below. Sections which follow discuss the actual results of the evaluation and how the most promising individual components were integrated into the four comprehensive motorist information concepts. The last section of the chapter discusses the application of these concepts to a local area.

Evaluation Criteria

To more objectively identify the effectiveness of potential motorist information system components, a set of evaluation criteria was established. The criteria were based on the functions the system components would need to perform to adequately meet the information needs.

The evaluation criteria presented here apply to the entire process of providing motorist information, from data collection to the transmittal of information back to the motorist. In fact, because of the distinction between the data collection, consolidation, and transmittal processes, separate criteria are needed for the evaluation of these three MIS components. A list of the evaluation criteria is presented in Table 8 while more detailed descriptions are contained in Appendix A.

Evaluation Methodology

Cost-effectiveness methodologies have long been used to weigh alternative courses of action. Unfortunately, a full cost-effectiveness analysis is not practical for this evaluation, primarily because many of the costs are difficult to quantify in the absence of a specific geographical setting in which given quantities of hardware and personnel can be deployed. Another common approach to the evaluation of relative system effectiveness is to estimate the relative weight which is appropriate for each aspect of the system's operation, in other words, to weight the criteria and develop an effectiveness scale for each system or componerit of the system.

The above approach was employed in the evaluation of MIS concepts for this study. The evaluation was conducted separately for all three MIS components: data collection, consolidation, and transmittal. This evaluation serves as the basis for eliminating certain concepts from further consideration and provides the rationale for packaging the concepts later in this chapter.

Several steps were involved in the evaluation process. First, weights were assigned to the various criteria to express the relative importance of each criterion. The criteria weights were first developed individually by each research team member, followed by a process of negotiation in a group session to derive an agreed-upon value. For each set of criteria (data collection, consolidation, and transmittal) 100 total points were allocated among the criteria relating to component effectiveness. For each alternative concept, a numerical rating was assigned, either 0, 1, or 2, with 2 being the highest rating and 0 being the lowest rating.

Table 8. Evaluation Criteria[1]

Criteria for data collection components

- Information currency (is information provided by the source current?)
- Reliability of source (individuals able to give accurate information?)
- Coverage of the source (is source able to be where he/she needs to be at a given time?)
- Communication with the source (is the method of communication between the source and the consolidation center dependable and of good quality?)
- Detail of information available to the source (how much detail is the source in a position to know?)
- Institutional constraints
- Near-term implementability

Criteria for consolidation centers

- Quality of output
- Timeliness of output
- Personnel considerations (flexibility of personnel and of hiring process)
- Institutional constraints and near-term implementability

Criteria for transmittal methods

- Reliability (is medium consistently able to get information to the motorist?)
- Transmission delay (response time of the medium)
- Information content (amount of information which can be transmitted)
- Penetration into user groups
- User selectivity (ability of the medium to focus distribution on a select user group)
- Legal/Institutional Constraints
- Near-term implementability

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1 Refer to Appendix A for detailed descriptions of these criteria.

Two methods of using the weighting/rating process were employed. The ratings were first used in a general way to identify strengths and weaknesses of each concept. In addition, a composite effectiveness score was developed for each concept by multiplying the rating for each criterion by the corresponding criteria weight. Thus, a perfect score would be 200 points.

It is important to consider the results of the above procedure as order-of-magnitude estimates only, as the process of weighting and ranking is largely judgemental. The value of such an exercise is not necessarily the final effectiveness value placed on each concept or alternative. Rather, going through the process of determining the effectiveness values forces the evaluator to seriously consider the pros and cons of each concept and the relative importance of various aspects of providing motorist information.

The cost of providing motorist information is an important input to the determination of feasible systems and an interesting one to attempt to quantify. There are several complicating factors in the process of estimating system costs. First, the costs are often allocated among a number of groups, including motorists, various government agencies, and private enterprises. The feasibility of some systems may depend on the group to whom costs will be allocated. In addition, certain MIS components have benefits which are not directly related to motorist information, and the costs associated with providing these additional benefits cannot be easily separated from the overall system costs. Finally, it is difficult to quantify some of the more obscure costs associated with some concepts, such as the administrative and management costs.

The approach taken in the analysis of costs was to quantify all cost elements to the extent possible, realizing that, like the effectiveness estimates, the cost estimates are of an order of magnitude nature. Costs are specified in the next section for selected system components. Although total system costs could not be specified for the generic concepts, they were specified in detail for the Washington, D.C. case study, presented in Appendix B (a separately bound volume).

IDENTIFICATION AND EVALUATION OF ALTERNATIVE MOTORIST INFORMATION SYSTEMS

This section summarizes a range of potential motorist information concepts for the three types of information (dynamic, semidynamic, and static) and for the three basic MIS components (data collection, consolidation, and transmittal). Most of these concepts have been previously discussed in Chapter 3. Conclusions regarding the potential use of each concept are summarized in this section in tabular form. In addition, a numerical evaluation of each concept is presented.

The summary table for dynamic information is presented first (Table 9). Within dynamic information, data collection alternatives are first presented, followed by consolidation and transmittal alternatives. Following Table 9, Tables 10 and 11 present a summary of alternatives for semidynamic and static information, respectively, Some of the alternatives are duplicated for the three types of information, since certain concepts may be appropriate for more than one information type.

Table 9. Summary of Conclusions Regarding MIS Components for Dynamic Information

Alternative Components	Conclusions
Data Collection	
Traffic/incident data from police	Use police primarily for incident status data. Traffic condition data not a primary function of police and will not be consistently available when needed. Pursue automation of incident status reports to eliminate need for frequent telephone communication.
Traffic/highway condition data from highway depts.	Use highway departments primarily for highway condition status reports (snow conditions, etc.). Coverage of highways by DOT field personnel not sufficient to provide adequate traffic condition data. Pursue automation of highway condition status reports to eliminate need for frequent telephone communications.
Weather services	Will continue to be an important source of data for MIS's.
Special roadway authorities	Function similar to highway departments and are a source of data which should be tapped, where such authorities exist.
Surveillance and control systems	Full advantage should be taken of the information gathering capabilities of surveillance and control systems, where they are available. Traffic status reports or computer graphic displays generated at the system's control center should be available at the MIS consolidation center. In some cases, the system control center may serve as the consolidation center for that zone. More work is needed on integrating traffic control systems for the surface street network into the information system.
Employed mobile observers (ground-based)	Recommended for use when airborne observers cannot be used due to weather or air traffic control restrictions.
Employed mobile observers (airborne)	Preferred over ground-based observers because of greater efficiency and timeliness of coverage for urban traffic conditions.
Regular commuters (volunteer. or paid a nominal fee)	Regular commuters in an urban area are an inexpensive and, if properly managed, reliable source of traffic information. It is recommended that maximum use be made of regular commuters in obtaining MIS data, using either mobile radios or mobile telephone as the communications medium.

Table 9. Summary of Conclusions Regarding MIS Components for Dynamic Information (Continued)

Alternative Components	Conclusions
Fixed observers	The MIS should take advantage of observers already stationed at key traffic observation points for other reasons (toll booths, bridges, etc.). Observers specifically paid for observation at a fixed point may be cost-effective where a large area can be seen (e.g. from a tall building). Volunteer observers at fixed positions may be appropriate under certain conditions.
CB radio monitoring	A system of CB radio retransmitters may be a practical way to acquire traffic information from motorists in urban areas. A CB channel could be designated on highway signs as the channel over which to report traffic information, and this channel should be monitored at the consolidation center, with two-way communication used to acknowledge and verify the information, but not to give information out. Recorded information could be disseminated over another channel.
Volunteer monitoring groups	Volunteer CB monitoring groups have primarily been oriented toward the reporting of accidents and other emergency situations. It would be difficult to extend this function to the reporting of general traffic conditions. Reports of incidents which are obtained from organization members are generally reliable unlike those of untrained non-members. Volunteer groups can be a useful part of a MIS if their interest is maintained.
Arrangements with transit and taxi companies	Although transit and taxi companies have vehicles in the field which are in a position to gauge traffic conditions, traffic information may not be of the quality required for direct use. If information is obtained from this source, only data from pre-selected, trained personnel should be used. Taxi companies are unlikely to provide reliable information and are not recommended as a primary source for traffic information. Transit agencies, however, should be pursued as sources in those areas where they are capable and interested in providing traffic information.
Emergency services monitoring	Is not a major source of information, although early tips on incidents can be picked up and verified. May be a more important source if communication between police and the consolidation center is deficient.

Table 9. Summary of Conclusions Regarding MIS Components for Dynamic Information (Continued)

Alternative Components	Conclusions
<u>Data Consolidation</u>	
Use of state/local police offices as consolidation centers	The gathering and consolidation of traffic information is not a major function of most police departments. Therefore, it is recommended that the police department not serve as the consolidation center for medium to large urban areas. However, the state police are a possible choice for serving as consolidation centers for small urban and rural areas where traffic problems are rare and where major incidents create the primary traffic information need.
Use of highway depts. as consolidation cen ters	Highway departments are not generally set up to manage the consolidation of dynamic traffic information. Although this function could be viewed as being part of their role, the stringent time and personnel requirements would make it difficult for the highway departments to perform this task. The optimum arrangement is for the highway department to work cooperatively with a private traffic service or, where profitability of a private service is marginal, to contract with a private traffic service.
Use of private traffic services	It is recommended that private traffic services continue their role as the primary consolidators of dynamic information in medium to large urban areas. Such services have proved to be financially viable and already have an effective structure of information sources and consolidation procedures. A more zone-specific approach needs to be taken in the consolidation of data to achieve the timeliness and levels of detail required for effective traffic information. Such services are not likely to be viable in rural and small urban areas.
Surveillance and control system as a primary consolidation center	If a S & C system were to cover an entire urban area, it could also serve as the primary consolidation center. Since such systems typically cover only a portion of the urban area, other inputs are also required. A private traffic service is usually better equipped to manage the data collection and consolidation functions outside the area covered by the S & C system.
Commercial Radio Station as consolidation center	Although many commercial radio stations have taken the initiative to collect and consolidate traffic data, the information given to the motorist has not been as comprehensive and high quality as is necessary to meet motorist needs. Commercial radio stations best serve as disseminators of information rather than as consolidators.

Table 9. Summary of Conclusions Regarding MIS Components for Dynamic Information (Continued)

Alternative Components	Conclusions
<u>Information Transmittal</u>	
AM/FM broadcast	General broadcast of traffic information over AM/FM radio should be continued. The most logical arrangement is for the station to subscribe to the traffic information service, rather than each station developing its own data collection and consolidation system. Radio stations should be encouraged to subscribe to reports focussing on specific corridors, to foster better timeliness of the information, but the listening market will likely continue to dictate the information broadcast.
Traffic information on FM SCA channels	FM SCA channels have considerable potential as an effective means of broadcasting traffic information. Traffic information should be carried continuously on a subsidiary channel, with a tone generated at the beginning of the traffic report for specific zones, enabling the regular broadcast to be interrupted either automatically by the radio (based on a zone coding system) or manually by the driver. Special receivers will be necessary.
Telephone traffic information service	A support system of telephone numbers with recorded traffic information needs to be established if the motorist information potential of mobile phone units is to be realized. However, it is unclear whether such a system would be utilized enough to justify it. If done, separate numbers should be available for each major corridor or zone within an urban area, and information should be refreshed at least every 15 minutes during commuting hours and as needed at other times.
CB radio traffic information channel	It is possible that a CB radio channel could be designated for transmission of recorded traffic information messages. The channel must be different from any channel used to collect data and should be designated on highway signs. Retransmitters would be located in appropriate urban area corridors, and recorded traffic messages would be specific to that corridor. Messages should be refreshed each 15 minutes. Experimentation with such a system is recommended.
NOAA Weather Radio	It is recommended that the use of NOAA weather radio be pursued as a transmittal medium primarily for rural rather than urban areas. Police and/or highway departments could develop ready-to-read reports which can be electronically sent to the appropriate NOAA broadcast station. Reports should focus on special traffic conditions, such as major incidents or construction.

Table 9. Summary of Conclusions Regarding MIS Components for Dynamic Information (Continued)

Alternative Components	Conclusions
Highway Advisory Radio	HAR installations should continue to be provided at key locations of recurring traffic congestion or frequent incidents. Messages may be either pre-recorded or re-recorded periodically, but would normally be selected or recorded by consolidation center personnel or by someone with direct observation of the site. AHAR is not currently practical.
(Mobile HAR	A mobile vehicle equipped with HAR would be ideal for use at major incidents. It is recommended that this application of HAR be investigated.
ARI	ARI systems are likely to continue their expansion in the U.S., but the extent of their penetration is unclear. Traffic reports will need to become more zone-oriented with more detailed information provided by zone before the potential of ARI can be better utilized.
Cable TV	A traffic channel (either exclusive **or** combined with other information) could be designated for cable TV. The existence of a viewer market is questionable.
Mobile telephone technology	Rapid advances in mobile telephone technology are increasing market for mobile phones, but proportion of equipped vehicles is still expected to be small. FHWA concern is primarily how to use mobile phone developments in MIS's.
Induction/low power radiation to in-vehicular computer	This technology would allow data to be transmitted to passing motorists equipped with in-vehicular computers. Computers could completely or selectively capture data, which would be available for display or voice-synthesized, either immediately or at the driver's command. System is not low-cost, and experimentation for MIS purposes may or may not be appropriate, depending on direction taken by auto industry.
Satellite digital transmission to in-vehicular computer	Similar to roadside transmission, except that on-board computer would have to query an MIS data base rather than serve a passive role only. Probably impractical for dynamic information.
Variable message signs	Will likely be used primarily in conjunction with surveillance and control systems. However, consolidation center could operate strategically located signs independent from a S & C system. Mobile variable message signs (limited format) may be applicable for use at major incidents.
Direct broadcast satellite	Is not well suited for provision of motorist information and would be limited to fixed locations.

Table 10. Summary of Conclusions Regarding MIS Components for Semidynamic Information

Alternative Components	Conclusions
Data Collection	
Highway/traffic departments	Are important providers of construction-related information and should be included as a source for auto clubs, travel agencies or other groups serving as consolidation centers.
State/local police	Have relatively little involvement with semi-dynamic information and do not need to be included as a source.
Weather services	Partly covered under dynamic information. Weather forecasts are an information need but are typically already well-covered.
Map, atlas, tour guide publishers	Are a primary source of semi-dynamic information. As further developments of microcomputer continue, more of this information may be distibuted in digital form.
Mobile observers	Primarily employed by auto clubs to collect and verify lodging accommodations, restaurants, attractions, etc.
Service chains	Are primary sources for lodging, restaurant and vehicle services information.
Individual commercial establishments	Individual establishments need to be contacted when not in a chain or when special local data need to be obtained. Typical information needed is on pricing, location and hours of operation.
Chambers of Commerce	Usually serve as intermediate consolidation centers themselves. Would generally carry a variety of information but more detail would usually have to come directly from the source.
Data Consolidation	
Auto clubs, travel agencies and similiar organizations	Auto clubs currently serve as consolidation centers for semi-dynamic information, primarily for pre-trip, but could also serve enroute needs.
Chambers of commerce	Serve as an intermediate consolidation point, but also serve many motorists directly.

Table 10. Summary of Conclusions Regarding MIS Components for Semi-Dynamic Information (Continued)

Highway/traffic departments	Type of information handled by highway departments are fairly limited and, therefore, they are not well-suited to serving as a consolidation center for semi-dynamic information.
Private advertising firms	Are expected to play a major role as additional communications and advertising media are developed. Are particularly well-suited to certain enroute information needs and are in keeping with the low-cost concept, in which as much of the expense of providing the information as possible should be borne by the private sector or users of the information.
<u>Information Transmission</u>	
Daily newspaper	Are useful for providing local information to those unfamiliar with the area. Column on daily construction activities has been used in a number of areas, but use of the information is probably minimal.
Maps/guides	Will continue to be primary methods of information transmittal. Consideration should be given to digitizing much of the information for use in in-vehicular computers. For example, memory modules could be rented or checked out of a library, containing motorist services information for the region through which a trip was being taken. Better use could be made of the mileposting system in relating vehicle location to motorist services.
Highway advisory radio	HAR practical for many situations involving semi-dynamic information. Commercial uses still limited by FCC regulation. AHAR not yet practical.
Fixed-base telephone	A transmittal method for pre-trip information. A data base on services information could be accessed via computer and modem, reducing the time and effort required to gather the information. This could be a service offered by an auto club or private advertising firm.
Mobile telephone	Could access same information as fixed-base phone.
AM/FM radio advertising	Not an effective method for getting semi-dynamic information to the motorist.
Information centers (manned and unmanned)	Will continue to play a role in providing motorist information, primarily along interstates and at major attractions.

Table 10. Summary of Conclusions Regarding MIS Components for Semi-Dynamic Information (Continued)

Information Terminals	These would include terminals located at rest areas, information centers, auto rental agencies, etc. to disseminate motorist services information. Units could be stand-alone with data in memory bank replaced periodically, or could be tied into a central computer with information downloaded periodically.
Induction/low power radiation to in-vehicular computer	Same concept as described for dynamic information could also be used for semi-dynamic. Information on tape or disk in roadside units would have to be re-recorded periodically.
Satellite digital transmission to in-vehicular computer	Same concept as described for dynamic information could also be used here.

Table 11. Summary of Conclusions Regarding MIS Components for Static Information

Information Transmission	
General Service Signs	Will continue to be prevalent, especially on the Interstate system. Their effectiveness is limited by the lack of details provided (no brand names, no indication of the number of services available). Recent changes to MUTCD allows use of directional arrows to better guide motorists.
Specific Service (Logo) Signs	Have been shown to be an effective method for displaying information which is quickly recognized by motorists. Information on quality, type, etc. is communicated through the brand names. Services which do not have nationally recognized logos could be at a disadvantage. Due to the number of services in typical urban areas, logo signs are felt to be most appropriate in rural or small urban areas.
Official Business Signs	Can provide directional information to most non-services locations. Directional and official signs permitted in most states beyond right-of-way, but with varying interpretations. Vermont, New Hampshire and New York have used an effective variation within the right-of-way.
Other standard signs	All other applicable static signs currently authorized in the MUTCD communicate information effectively.
Outdoor Advertising signs	These signs have historically provided information to motorists, however their effectiveness is questionable. Considered by some to be visually unattractive and distracting, regulations limit their use and thus they do not offer comprehensive information' concerning available services. This combined with their lack of objectivity prohibits them from being a part of a coordinated, comprehensive system.
Audio signing	An automatic system would be required to warn of hazardous conditions such as a dangerous curve. While the system could be effective, the costs are prohibitive.
Printed material	Maps and guides can provide some static information such as toll information, locational information, and roadway characteristics. Comments from semi-dynamic information table concerning use of in-vehicular computers and better use of milepost system also applicable here.

The following is a listing of the alternative MIS concepts in the order in which they are presented.

Data collection for dynamic information

- State/local police
- Highway/traffic departments
- Weather services
- Special roadway authorities
- Surveillance and control systems
- Mobile ground-based observers
- Airborne observers
- Regular commuters via phone or radio
- Fixed observers
- Motorist via CB radio
- Volunteer monitoring groups
- Transit/taxi system
- Emergency services monitoring

Data consolidation for dynamic information

- State/local police
- Highway/traffic departments
- Private traffic service
- Surveillance and control centers
- Commercial radio station

Transmittal for dynamic information

- A M/FM broadcast
- FM SCA channels
- Telephone information system
- CB monitoring - general
- CB monitoring - publicized channel
- NOAA weather radio
- Highway advisory radio (HAR)
- Automatic highway advisory radio
- Mobile HAR
- ARI
- Cable TV
- Radiotelephone
- PRCS
- Induction/low power radiation to in-vehicular computer
- Satellite digital transmission to in-vehicular computer
- VMS - limited format
- VMS - unlimited format
- Mobile VMS
- Direct broadcast satellite

Data collection for semidynamic information

- Highway/traffic departments
- State/local police
- Weather services
- Map, atlas, tour guide publishers
- Mobile observers
- Service chains
- Individual commercial establishments (restaurants, hotels, etc.)
- Chambers of commerce

Data consolidation for semidynamic information

- Auto clubs, travel agencies and similiar services
- Chambers of commerce
- Highway/traffic departments
- Private advertising firms

Data transmission for semidynamic information

- Daily newspaper
- Maps/guides
- HAR/AHAR
- Fixed-base telephone
- Mobile telephone
- Manned information centers
- Unmanned information centers
- AM/FM radio advertising
- Information terminals
- Induction/low power radiation to in-vehicular computer
- Satellite digital transmission to in-vehicular computer

Data transmission for static information

- General service signs
- Specific service (logo) signs
- Official business signs
- Other standard signs
- Outdoor advertising signs
- Audio signing
- Printed material

Tables 12 through 14 present an indication of the relative degree to which each concept for dynamic and semidynamic information satisfies the evaluation criteria discussed in the previous section. The evaluation methodology presented previously was utilized for this analysis. This evaluation procedure was not appropriate for static information systems; however, Table 11 includes a general evaluation. within the discussion of each transmittal method. The evaluation shown in the tables, along with the individual evaluations presented in Tables 9, 10, and 11, serve as the basis for refining and packaging the concepts in the next section.

Table 12. Evaluation of Data Collection Sources

Source	Info Currency	Source Reliability	Coverage of Source	Comm with Source	Info Detail	Near-term Implementability	Management/ Institutional Constraints	Total Score
For Dynamic Information								
Criteria Weighting	20	20	15	10	15	10	10	
Highway/Traffic Departments								
-Electronic	2	2	1	2	1	2	0	150
-Telephone	1	2	1	1	1	2	1	130
State/Local Police								
-Electronic	2	1	2	2	1	2	1	155
-Telephone	1	1	2	1	1	2	2	135
Weather Services	2	2	2	2	2	2	2	200
Special Roadway Authorities	1	1	0	1	1	2	1	95
Motorists via CB Radio								
-Centralized (urban/rural)	2/2	1/1	2/1	1/1	1/1	2/2	1/1	145/130
-Decentralized (urban/rural)	1/1	1/1	2/2	1/0	1/1	2/2	2/0	135/125
Commuter Contacts	2	2	1	2	1	2	1	160
Airborne Observers	2	2	2	2	2	2	2	200
Mobile Surface Observers	2	2	1	2	1	2	2	170
Fixed Observers	2	2	0	2	1	2	2	155
Volunteer Monitoring Groups	1	1	1	2	0	2	1	105
Transit/Taxi Systems	1	1	2	0	0	2	0	90
Surv. and Control Systems	2	2	1	2	2	2	2	185
Emergency Svcs. Monitoring	2	1	1	1	0	2	2	125
For Semidynamic Information								
Criteria Weighting	10	25	20	10	20	5	10	
Highway/Traffic Departments								
-Electronic	1	2	1	2	2	2	1	160
-Telephone	1	2	1	1	2	2	2	160
State/Local Police								
-Electronic	1	1	1	2	0	2	0	85
-Telephone	1	1	1	1	0	2	1	85
Weather Services	2	1	2	2	2	2	2	175
Map/Atlas/Tour Guide Publishers	2	2	1	2	2	2	2	180
Mobile Observers	2	1	1	2	2	2	2	155
Service Chains	2	2	2	2	2	2	2	200
Individual Establishments	2	2	1	2	2	2	2	185
Chambers of Commerce	2	1	1	2	1	2	2	135

Note:See precautions about application of this evaluation in text.

Key: 2 - Highest
0 - Lowest

Table 13. Evaluation of Consolidation Centers

Consolidation Center	Quality of output	Timeliness of Ouput	Personnel Consid.	Institutional Problems	Total Score
For Dynamic Information (urban/rural)					
Criteria Weighting	25	25	30	20	
Highway/Traffic Departments	1/1	2/1	2/1	1/1	155/100
State/Local Police	1/1	1/2	1/2	0/1	80/130
Private Traffic Service	2/1	2/1	2/1	2/1	200/100
Surveillance and Control Centers	1/-	2/-	2/-	1/-	155/-
Commercial Radio Station	2/1	1/0	1/1	2/1	145/75
For Semidynamic Information					
Criteria Weighting	20	35	25	20	
Auto Clubs, travel agencies, etc.	2	1	2	2	175
Chambers of Commerce	0	1	1	1	80
Highway/Traffic Departments	1	1	1	1	100
Private Advertising Firms	2	1	2	2	175

Note: See precautions about application of this evaluation in text.

Key: 2 - Highest
0 - Lowest

Table 14. Evaluation of Transmittal Media

Transmittal Media	Reliability	Info Delay	Info Content	Time Frame Available	Penetration	User Selectivity	Legal/ Institutional Constraints	Total Score
<u>For Dynamic Information</u>								
Criteria Weighting	20	20	10	10	15	15	10	
Telephone Information System	1	1	2	2	1	1	1	120
Telephone with Computer	1	1	2	1	0	1	1	95
AM/FM Broadcast	2	2	1	2	2	0	2	160
ARI	2	2	1	2	1	1	1	150
FM SCA	2	2	2	2	1	1	1	175
FM SCA with Display	2	2	2	1	0	1	1	150
TV Broadcast	2	2	1	2	1	0	2	145
Cable TV	2	2	2	2	1	1	2	170
NOAA Weather Radio	2	2	1	2	1	0	2	145
CB Monitoring								
-General	0	2	2	2	0	1	1	105
-Publicized Channel	1	2	2	2	1	1	0	130
Highway Advisory Radio (HAR)	2	2	2	2	1	2	1	175
Mobile HAR	2	2	2	1	2	2	1	180
Radiotelephone	1	1	2	2	0	1	1	105
Radio Paging	1	2	2	1	0	1	1	115
TV SCA	2	2	2	1	1	0	1	135
AHAR	2	2	2	1	0	2	2	140
Induction/Low Power Radiation	2	2	1	1	0	2	2	150
Satellite Digital Transmission to In-vehicular Computer	1	2	2	0	0	0	2	100
PRCS	1	1	2	1	0	1	0	85
Direct Broadcast Sattelite	1	2	2	0	0	1	0	95
Variable Message Signs								
-Limited Format	2	2	0	2	2	2	2	180
-Unlimited Format	2	2	1	2	2	2	2	190
Mobile Variable Message Signs	2	2	1	2	2	2	2	190

Note:See precautions about application of this evaluation in text.

Key: 2 - Highest
0 - Lowest

Table 14. Evaluation of Transmittal Media (Continued)

Transmittal Media	Reliability	Info Delay	Info Content	Time Frame Available	Penetration	User Selectivity	Legal/ Institutional Constraints	Total Score
For Semidynamic Information								
Criteria Weighting	20	5	20	10	20	15	10	
Daily Newspaper	2	2	2	2	1	1	2	165
Brochures	1	1	2	2	0	0	2	105
Maps/Guides	2	1	2	2	1	2	2	175
Unmanned information centers	1	2	1	2	1	2	1	130
Manned information centers	2	2	2	2	1	2	2	180
HAR	2	2	2	1	2	2	1	180
AHAR	2	2	2	0	2	2	0	160
Fixed-Base Telephone	2	2	2	2	0	1	2	145
Radio Telephone	2	2	2	1	1	1	1	145
Radio telephone with computer	1	2	2	1	0	2	1	120
AM/FM Radio Advertising	2	2	2	2	0	0	2	120
Information Terminals	2	2	2	1	1	2	2	170
Induction/Low Power Radiation with In-vehicular Computer	2	2	2	0	1	2	0	140
Satellite Digital Transmission to In-vehicular Computer	2	2	2	0	0	1	0	105

Note: See precaution about application of this evaluation in text.

Key: 2 - Highest
0 - Lowest

Cost data for most of the data collection and transmittal components are shown in Table 15. Most of the costs are order-of-magnitude estimates, as there are a number of variables (e.g., city size, changes in technology) which can affect the cost range. It is not practical at this stage to develop overall system costs due to the diversity of possible system configurations, urban area sizes and other factors. However, the overall system costs could be estimated from the data in Table 15 and other sources given a specific system configuration.

INTEGRATION OF SYSTEM COMPONENTS INTO COMPREHENSIVE MIS PACKAGES

Based on the evaluation of individual motorist information system components in the previous section, a series of overall concepts was prepared. These overall concepts integrate the most promising data collection, consolidation, and transmittal methods to form a set of MIS packages which address the motorist needs identified earlier.

The MIS concepts are oriented around several key findings which have been indicated in the previous sections. First, separate concepts are designed to address dynamic, semidynamic, and static information needs. In addition, it was found necessary to distinguish small urban and rural areas from medium to large urban areas within the dynamic information category. Finally, it was necessary to distinguish between various technology levels, some of which are existing or immediately implementable while others are considered future technology. The basis for making the above distinctions is as follows:

1. Division of systems based on information type

Data collection and consolidation functions for the three basic information types (dynamic, semidynamic, and static) are largely independent of one another. The data sources for dynamic information are quite different from those needed to supply semidynamic (primarily services) information. In addition, the consolidation functions for all three information types have quite different requirements, one dealing with highly time-critical information (dynamic) pertaining to recurring traffic congestion, incidents, etc., another oriented toward services information (semidynamic) which is of a much less time-critical nature and has completely different content from dynamic information, and a third in which the consolidation center rarely, if ever, has to be concerned with changing the information originally prepared (static information). The dramatic differences between the data collection and consolidation functions for the three information types enable these functions to be carried out independently. For example, the collection of traffic congestion data (dynamic) is independent of the process of collecting information on hotel accommodations (semidynamic). However, similar transmittal medium may be used for two or more systems (e.g., telephone may play a prominent role in both dynamic and semi-dynamic systems).

2. Rural versus urban areas

For dynamic information, medium to large cities with recurring traffic congestion require a different data collection and consolidation process than rural and small urban areas. The primary reason for this is evident when one considers the traffic characteristics of the two areas. In a large urban area,

Table 15. Cost Data for Selected System Components

Component	Capital cost	Maintenance and Operating Cost	On-going Labor cost
Data Collection			
Police/DOT information terminals	$5,000 plus $2,000 per station	$50/month/sta. phone charges	1/2 hour extra tirne per peak period for data input
CB radio monitoring	$2,000/station	$200/month/sta. dedicated-line or $50/month dial-up	Monitoring time at consolidation ctr.
Commuter contacts		$.20/roadway mile* $2.00/day calling charge	Volunteer or norninal fee
Airborne observers		$.30-$.50/mile* of roadway observed	
Ground-based mobile observers		$1.00-$1.50/mile* of roadway observed	
Connection to surveillance and control system			
. reports	$15,000/station		
. graphics	$40-50,000/station		
Transmittal			
Telephone information system	$5-20,000 per line		
ARI	$l00-$150 additional cost for ARI receiver		
FM SCA Channels	est. $l00-$150 additional cost for receiver	$2,000/month channel rental	

*For cost per kilometer, divide cost per mile by 1.61.

Table 15. Cost Data for Selected System Components

Component	Capital cost	Maintenance and Operating Cost	On-going Labor cost
Cable TV	$200,000 equipment cost	channel time assumed to be provided as public service	variable - includes either production cost or cost of subscription to private traffic service
NOAA Weather Radio	$20/receiver		integrating traffic information into weather broadcast
CB Radio Channel (Publicized)	$2,000/station	$50/month/dial-up line	5 min./hr./station for recording
Highway Advisory Radio	$25,000/station	$50/month/sta. dial-up line	5 min./hr./station for recording
Mobile HAR	$16,000/unit		recording during incidents
AHAR	$28,000/station +250/receiver in mass production		5 min./hr./station for recording
Roadside digital transmission	$15,000/station +$200-500 in-vehicular computer	$50/month/sta. dial-up	variable - time required for generating and transmitting data from computer at consolidation center
Cellular phone	$1,500/unit or $100/month rental	$0.40/minute	
PRCS	$300-450/unit	less than $20/mo. (estimated)	

there is a much larger quantity of usable information to report, and thus there is a much larger market to support a more extensive data collection and consolidation system. Rural and small urban areas, on the other hand, rarely encounter traffic problems; and those problems which do occur are typically related to major traffic incidents and weather problems. Therefore, in rural areas, the frequency of the need for dynamic information is relatively low, and the motorist information system needs to address traffic delay and alternate route information only sporadically. In addition, rural areas are geographically large, and it would be difficult to collect information for the entire area continuously.

3. Future changes in technology

As technology evolves, certain methods of operation (especially information transmittal methods) will be replaced by more advanced methods of operation. The motorist information concepts must make allowances for future changes in technology. The approach taken in the development of the concepts in this report is to identify both existing and future technologies, recognizing that existing technologies may be gradually phased out and new technologies phased in. Also, it is recognized that regional differences in geographic, economic, or social structures may indicate that some technologies are more appropriate than others in certain areas of the country, although there will be certain trends that are somewhat uniform throughout the U.S. The overall MIS concepts allow for flexibility in selecting techniques for application.

A final point should be made regarding the low-cost aspect of this study. A recognition has been maintained throughout this study that systems which are not affordable are not realistic alternatives. Therefore, emphasis has been placed on developing systems which are low in cost, both to the government and to the motorist. Regarding governmental costs, substantial thought has been given to ways of keeping the private sector involved in the provision of motorist information, thereby making the system as self-sustaining as possible. Regarding cost to the motorist, it is important to note that technologies which may be expensive today may not be expensive in ten or twenty years. Possibilities for these future technologies need to be envisioned, and have been included in the concepts so that a transition can be made into such technology when the cost is at a reasonable level. Some of these technologies may be developed for purposes other than motorist information, and the incremental cost for their serving motorist information functions may be relatively low.

The following sections discuss four basic motorist information system concepts:

- Dynamic information concept for a medium to large urban area.
- Dynamic information concept for a rural or small urban area.
- Concept for semidynamic information (covering both pre-trip and enroute needs).
- Concept for static information.

Concept for Dynamic Information in a Medium to Large Urban Area

Figures 17, 18, and 19 indicate the proposed concept for a motorist information system to handle dynamic information for a medium to large urban area. The figures present the concept in terms of its three primary components, data collection, consolidation, and transmission. It should be noted that not all of the data collection and transmission methods are recommended for every urban area. Some may simply not exist or may not be appropriate for a particular city, while others are designated as future concepts which cannot be immediately implemented. However, these future concepts need to be included in the figures to indicate how they will interface with the remainder of the system if and when such technology comes into being.

Consolidation Center

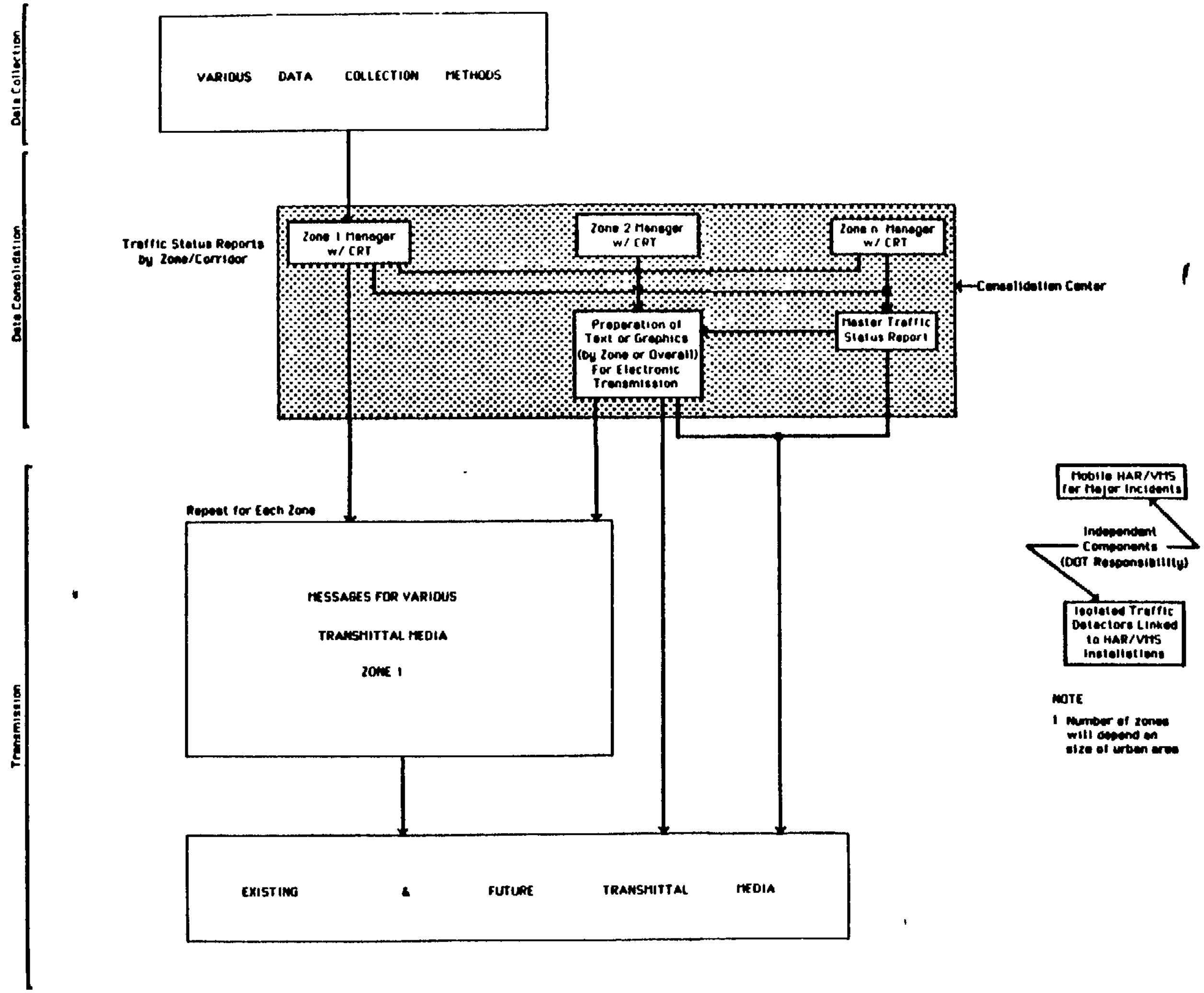
The heart of this MIS concept is the information consolidation center. A private traffic information service is best suited to the consolidation operation unless the urban area is completely covered by surveillance and control systems, in which case the control center might service as the consolidation center. However, this level of coverage will not be reached in most urban areas for many years. Therefore, the consolidation center shown in Figure 17 assumes operation by a private traffic information service. The urban area would be subdivided into zones or corridors which represented some degree of continuity in traffic flow and commuting patterns. An example would be a major freeway corridor, including parallel arterials and cross routes. The size of the zones would generally depend on the arrangement of the highway system and on the traffic activity within each zone.

The philosophy behind dividing the urban area into zones is to improve the detail of the information and the timeliness with which it is disseminated to the motorists enroute. If the information is oriented toward specific zones and corridors, a more detailed traffic report; can be given in the same amount of time as a more general region-wide report, and the audience can be more directly targeted. The total number of zones will depend on the size of the urban area, with some cities being able to be handled adequately with only one zone.

The zone managers would be individuals who process all incoming information and prepare the output for transmission. Alternatively, the zone management function could be handled by two persons, one to process incoming information and the other to prepare output. The latter arrangement would be used where the activity within a zone is too great for one person to manage both_ input and output. Output in this case includes verbal messages which may be either recorded for a variety of uses or presented live over radio media. Although the zone managers would operate somewhat independently, information would be passed among zones if necessary, especially in cases where there was reportable activity on the border between two zones.

In addition to the zone-by-zone reports, master traffic status reports would also be prepared, primarily for those radio stations which still wanted to have an overall, but less detailed, traffic report. An additional person would be responsible for preparing text or graphics for electronic transmission, either on **a** zonal basis or for the overall area. These are reports which could be directly read by users of the information; such as radio announcers or, in the case of graphics, used by television stations.

The zone managers would have direct contact with the data sources shown in Figure 18 and enter salient information into a computer with a CRT display. The recordings would be made based on the CRT information.



Concept for a Motorist Information System for Dynamic Information in Medium to Large Urban Areas - Consolidation Center Component

Figure 17

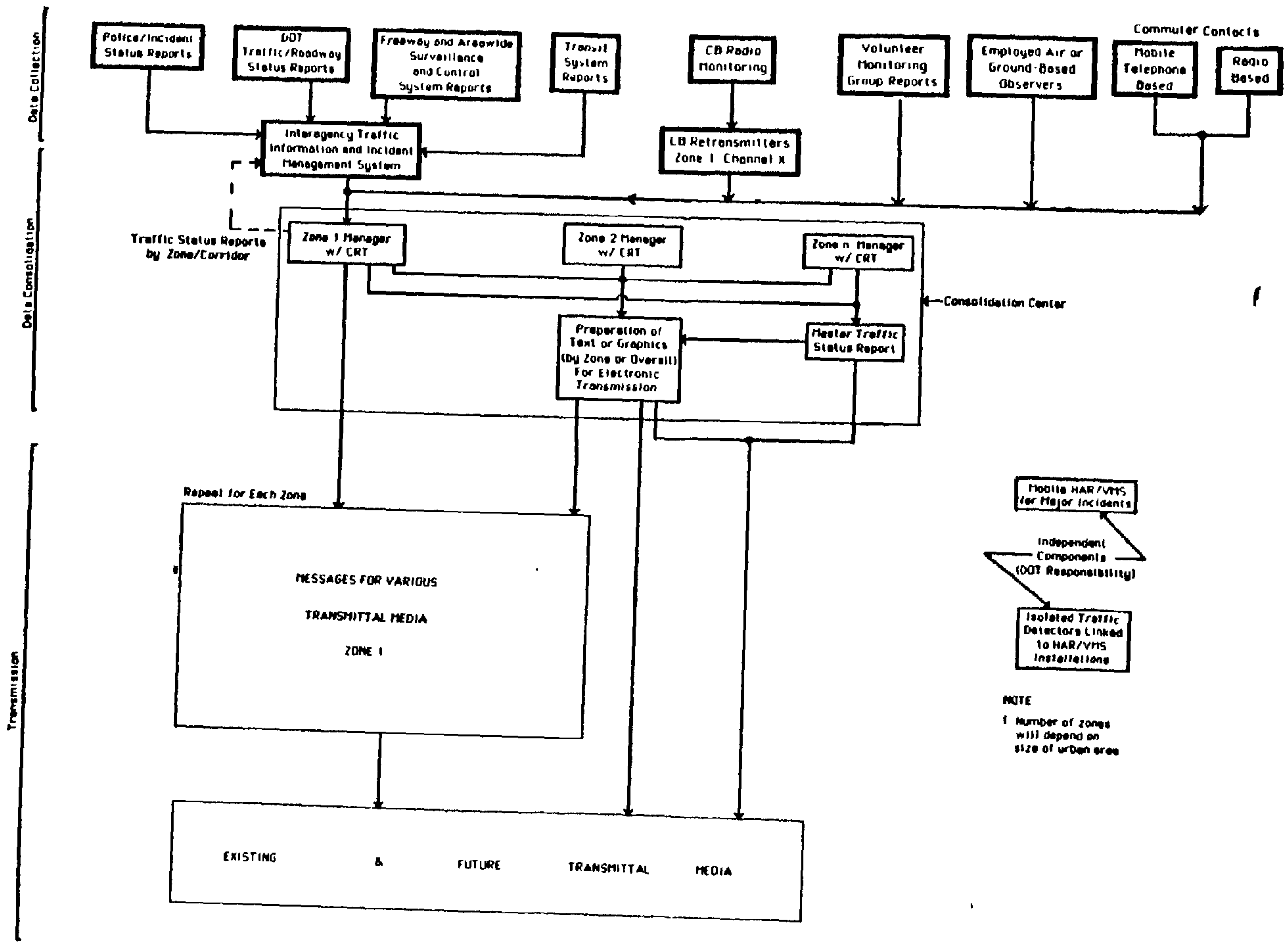
Data Collection

A wide range in data sources is possible for a large urban area, but not all of the sources shown in Figure 18 need to be used. Police departments are a source of information, but primarily for incident status (e.g., time left until incident is cleared) rather than traffic congestion data. In existing systems, the consolidation center would typically call the police department over the telephone to determine or verify the status of an incident. An enhancement of this connection which could be implemented in the near term would involve traffic incident status reports prepared on a CRT or other electronic media within the police department. Each time there was a change in the status, that change would be reflected in the report, which would be available for querying at any time by the consolidation center. The major advantage to both parties is that the number of telephone calls and the associated personnel time consumed can be greatly reduced. The major concern would be that proper attention be given to updating the traffic incident status reports. The police terminals should also be tied to other public agencies in an organized way to enable agencies to quickly share critical information on major incidents and emergency situations. This is represented by the box in Figure 18 into which the several public agency sources flow. Besides providing intermediate consolidation of information for the consolidation center, one of the functions of this interconnection would be to enhance the coordination between police departments, departments of transportation, and transit agencies. This system is envisioned as an electronic interconnection between the agencies, which permits input of the location and type of incident or condition. A list of required actions and the responsible agencies would then be generated. When an agency executes its required action, this is entered into the system which also provides status reports of the overall situation. These status reports would be available to the consolidation center, preferably through electronic means. The surveillance and control system in the Chicago area is planning to implement a system similar to this in the near future. There has been increasing awareness of the need for such a system to respond to various major emergencies which arise from time to time.

The departments of transportation (State or local) would interface with the consolidation center in much the same way as police departments. In this case, the primary information needed is of roadway conditions during adverse weather and details on roadway construction activities. Again, communications are currently of a telephone nature, but these could be transferred over to electronic media.

Surveillance and control systems may be available for some parts of urban areas. In fact, if surveillance and control systems extend over most or all of an urban area, the surveillance and control center might logically serve as the best consolidation center. However, it is likely to be many years before urban areas are that extensively equipped with surveillance and control systems. In the meantime, such systems will likely play a role as a major data source, such as will be done by the Shadow traffic network in New York with regard to the Integrated Motorist Information System (IMIS) on Long Island. A terminal in Shadow headquarters will be able to pick up status reports for the IMIS corridor, and this should add to the quality and quantity of data received.

Another source which could be used in some or all zones involves the monitoring of CB radio. Although the figure primarily implies general monitoring of motorist-to-motorist conversations on channel 19, one other potential CB radio arrangement would be to establish a separate channel over which motorists would be encouraged to report



Concept for a Motorist Information System for Dynamic Information in Medium to Large Urban Areas - Data Collection Component

Figure 18

traffic conditions, similar to the way in which emergencies are now reported on channel 9. CB retransmitters located in each zone would relay the information via land lines to the zone manager. Since it is difficult to monitor several CB retransmission stations at a time, CB radio monitoring would likely be oriented toward verification of information received from other sources. This is the emphasis of CB monitoring currently being conducted in Chicago.

CB radio monitoring can also be performed by volunteer monitoring groups such as REACT. These are shown as a separate data source since they provide intermediate consolidaton of the information. These groups would be appropriate in those areas where there is a strong, active organization and their interest can be maintained. Volunteers must be considered in any low cost system.

The concept shown in Figures 17, 18, and 19 is still expected to rely heavily upon employed observers, primarily airborne but also ground-based. Although more costly, these sources provide the highest quality information to the consolidation center. Less reliance on this source may be needed where a surveillance and control system is in operation.

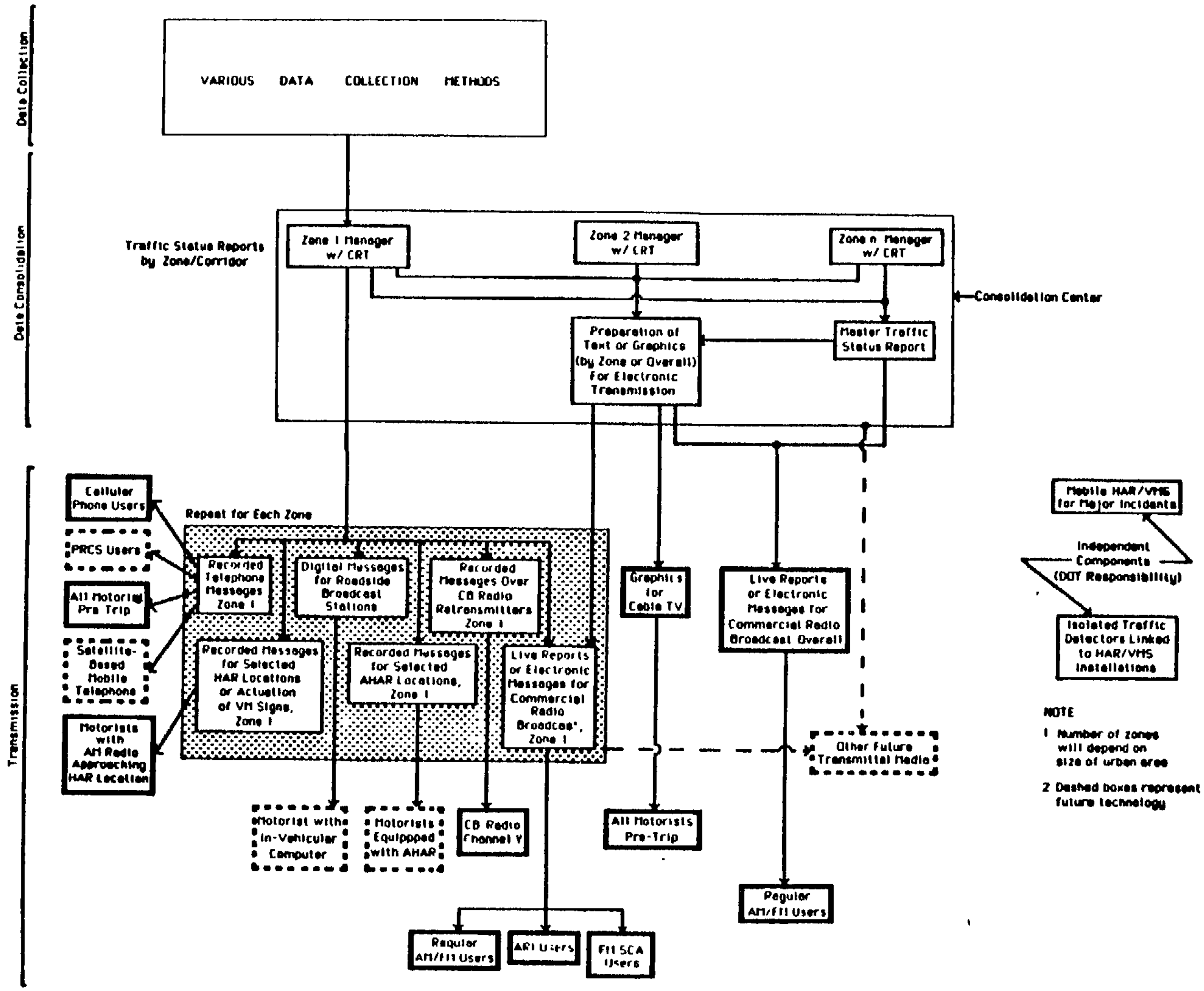
Another promising source involves the use of regular commuters providing traffic information to the consolidation center on a prearranged basis. These could be either two-way radio or telephone contacts. The major advantage of using regular commuters as a source is the low cost of the information, since the commuters would be serving primarily as volunteers, with direct costs (e.g., telephone charges) reimbursed by the consolidation center. However, this arrangement presents more of a management problem than the other sources.

Information Transmission

Once the information is consolidated and prepared for output it can be transmitted to the motorist in a variety of ways as shown in Figure 19. Not all of these ways would be appropriate for every urban area. The type **of** transmission selected would depend on the strategy for penetrating the particular motorist markets within that urban area.

If advantage is to be taken of the increasing availability of mobile telephones, a telephone-based system of traffic reports would have to be available. If a “traffic phone” concept is used, the consolidation center would be responsible for recording the telephone messages along with their other responsibilities to radio stations and other media. One possible funding arrangement would be for the telephone company, or some private organization, to subscribe to the services of the consolidation center, with the cost of the subscription recovered through advertising along with the traffic condition message. One possible concern raised by a telephone traffic information service is the accessibility it affords to the information, leading to the possible reuse of the information for some commercial purpose, diverting revenue from the consolidation center. However, the information presented would be legally protected by copyright laws. Enforcement of these laws is possible, but somewhat difficult.

The consolidation center could also supply recorded messages for selected HAR locations **or** even have the responsibility for actuation of various messages on selected variable message signs if there **were** any such signs in the area. The HAR or VMS locations would be placed at strategic diversion points on the highway system, and the messages would provide information on both traffic conditions and route choice.



Concept for a Motorist Information System for Dynamic Information in Medium to Large Urban Areas - Information Transmission Component

Figure 19

It is expected that live reports over commercial radio will continue to be a major activity, and the advertising will provide a primary source of funds for sustaining the traffic service. Trafficreports would ideally be oriented toward specific zones, this being supported by a system such as ARI or FM SCA channels as discussed earlier. Regular commercial radio broadcasts would continue but would be of less detail and not as timely as the zone-oriented reports.

The two boxes which are not connected to the main part of the figure indicate methods which could operate independently of the consolidation center. In some cases it may be appropriate to have isolated HAR or VMS installations linked to downstream traffic detectors which would activate predetermined messages, such as warnings of downstream congestion. Another application of HAR would be a mobile unit which could be used at major incidents. This would compromise a component of the overall system even though it was operated independently.

Much of the future technology indicated by the dashed boxes in Figure 19 is well on the way to becoming reality. In some cases, institutional constraints may delay their application. One of the more advanced technological concepts included in the figure is the transmission of digital messages from roadside broadcast stations or inductive loops into the in-vehicular computers of passing motorists. This is similar in concept to HAR except that 1) information is transmitted digitally instead of in the voice mode and 2) the stored messages can be accessed at the motorist's demand, rather than being available only when that point in the road is passed. Much development is yet to be done on this concept, however, and it is uncertain as to when it might become cost-effective.

In Figure 19, transmission is shown only for zone 1 and for the master traffic status report. Identical structures for transmission would exist for any other zones in the system.

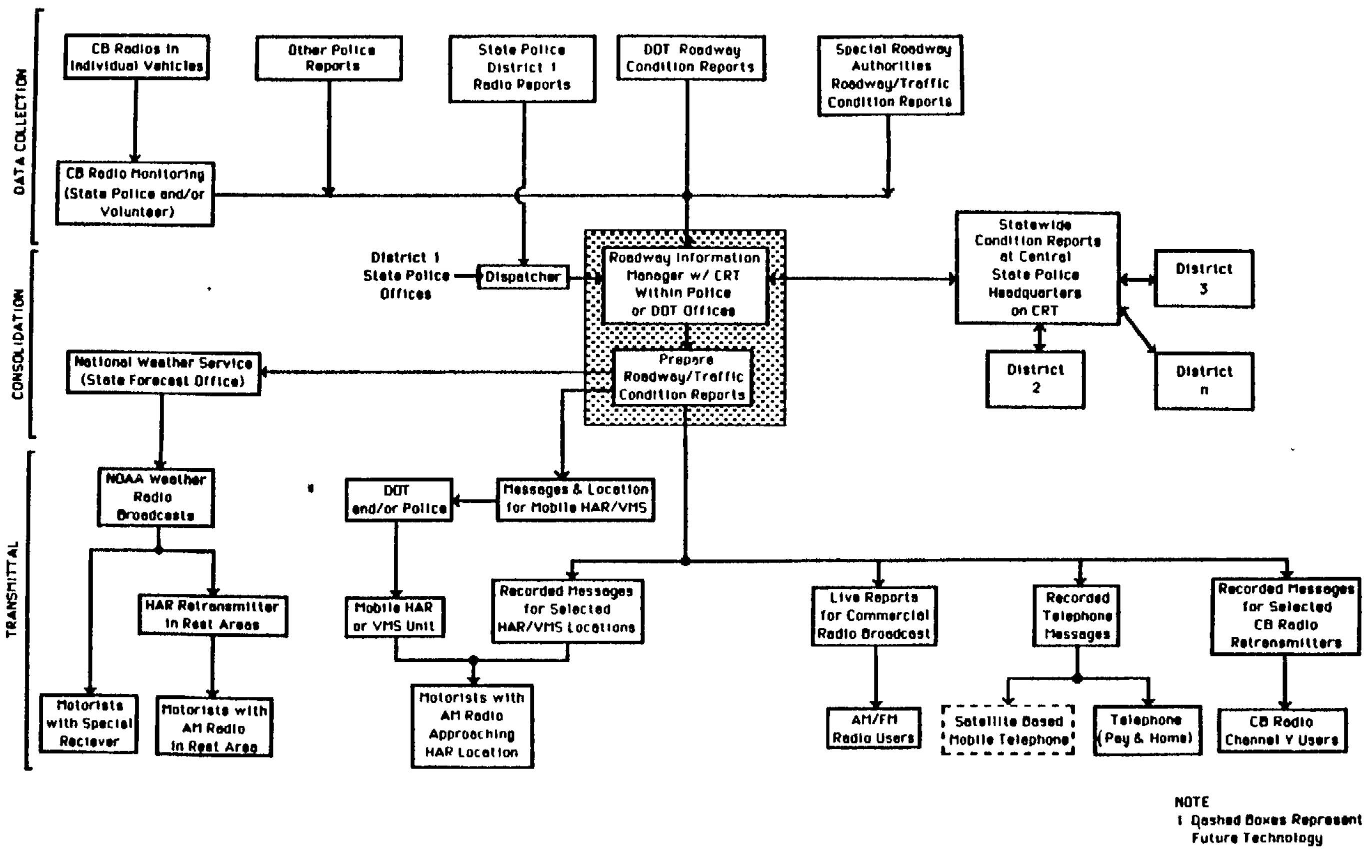
System Management

The advantages and disadvantages of various organizations operating a consolidation center for dynamic information have been discussed earlier. That evaluation indicated that a private traffic service would be most appropriate for the structure shown in Figures 17, 18, and 19. This is emphasized by the type of employment arrangements necessary (ability to hire and fire on short notice) and the need for professional radio type personnel to serve as zone managers. A surveillance and control center could serve as the consolidation center if there was enough urban area coverage and if the staff were available to make professional radio reports.

During off-peak hours, the consolidation center might be cut back to one staff person; or, depending on the city, off-peak traffic problems would be so rare as to not warrant any off-peak operation at all. Often, arrangements can be made for traffic reporters to be called or paged in the case of a significant off-peak incident so that unusual traffic conditions may be monitored.

Concept for Dynamic Information in Rural and Small Urban Areas

Figure 20 represents a concept for handling dynamic information in rural and small urban areas. In these areas, traffic conditions need to be reported only sporadically, usually in relation to traffic incidents or adverse weather conditions. In



Concept for a Motorist Information System for Dynamic Information in Rural and Small Urban Areas

Figure 20

this case, the consolidation center would need to operate only during times of unusual traffic conditions. This type of operation cannot be managed in the same way as an urban area operation since there is not enough activity to economically support a private traffic service, and even if there were a daily service, there would be little to report.

For rural and small urban areas, the consolidation center function would be managed by a public agency, most likely the police, but could also involve the highway department. The information system would essentially be inactive until a situation creating traffic congestion and delay occurred. Normally, the State police are the ones that have access to incident information and would therefore be a good choice for serving as the consolidation center for these congested or bad weather periods provided that they pay sufficient attention to disseminating the traffic information. Figure 20 shows a State police district office as the primary consolidation center.

In this concept, a roadway information manager, most likely a police department employee who performs other duties when there are no traffic problems, would obtain information either directly from field sources or from the dispatcher. The information manager would then be in a position to record messages or provide live reports for commercial radio, where necessary. One of the potential problems of designating police as the consolidation center for traffic information is the historical lack of attention given by police agencies to disseminating traffic information. This task is simply not seen as one of their priorities. Therefore, several alternative arrangements of the consolidation center might be considered. It may be possible within some police agencies to designate an individual who would have as one of his responsibilities the preparation of traffic reports and maintaining liaison with radio stations and other transmittal media. This person would be engaged in other activities until there was a major incident or other traffic disturbance.

In police agencies where it is unlikely that a staff member will be committed to the information dissemination responsibility, the services of a staff member from the State highway agency might be used. This option would assume that there is a good mechanism for the exchange of information between the police and highway agency. Ideally an electronic terminal connection could be provided. Incident information would be provided by the police and construction, detour, and road condition information would be provided by the DOT. If the highway information manager could be informed of the occurrence of congestion, it is possible that some information could also be obtained without police assistance, such as by monitoring police radio frequencies or CB radio. Perhaps even local auto clubs could play a role. An alternative would be the location of the DOT representative in the police offices for the duration of the congestion period. The primary consideration in any of these alternatives is that a specific individual be given the responsibilities of managing information when the need arises.

Data sources, also highlighted in Figure 20, would primarily be limited to field personnel of public agencies, as well as CB radio monitoring. CB radio monitoring would probably be more spotty in rural areas because of the greater area which is needed to be covered and the cost of providing such coverage. The exception to this is along heavily traveled corridors through rural areas. None of the other sources shown for urban areas (e.g., airborne observers or regular commuters) are practical in rural areas.

A number of the same transmittal methods as were used for larger urban areas could also be used for this concept; but some, such as recorded telephone messages and transmission over a CB radio channel, would not be as convenient. One of the transmittal methods with higher potential, however, is the inclusion of traffic information on broadcasts by the National Weather Service over NOAA Weather Radio. This method is not appropriate for large urban areas because it would not be well focused on the user group. However, it is more practical for rural areas where there is less traffic information to broadcast and there is not as much need to focus the report only on a specific group of users. To reach a significant number of motorists, however, these would need to be a substantial increase in the number of vehicles equipped with a NOAA weather radio receiver.

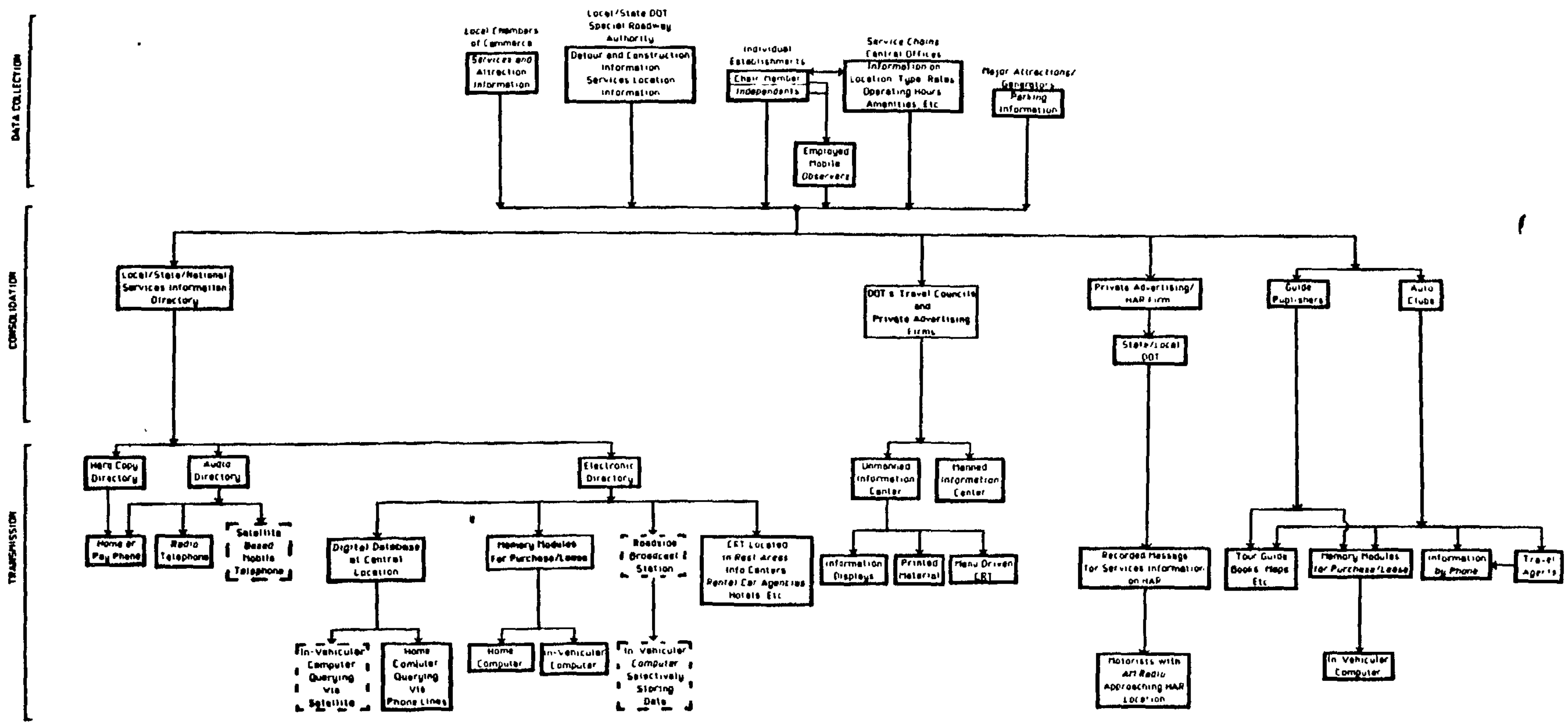
Normally, one police district would be responsible for gathering and disseminating information on a given incident. The individual district reports could then be sent to a central location, compiled and redistributed to the district offices. This would enable longer distance travellers to obtain current traffic information for locations outside their immediate area. This information could also be used internally by local auto clubs. The periodic recording of traffic/roadway condition information for motorists calling in on the telephone would relieve police from the time demands of personally answering each call.

Providing. motorist information for recreational routes and other situations with regular weekend congestion presents a set of circumstances between those presented in the two concepts for dynamic information. These cases would need to be addressed individually on the basis of the circumstances. If the route is near an urban area, it might be picked up by the private traffic information service. Others might be overseen by a special roadway authority.

Concept for Semidynamic Information

Figure 21 depicts a proposed concept for addressing semidynamic information needs. In this case there will be multiple consolidation centers, as there are a number of groups which may be providing information through different means. These organizations include auto clubs, travel agencies, advertising firms, travel councils, departments of transportation, and chambers of commerce, among others.

There are several important issues which need to be addressed in a system involving semi-dynamic information. One issue is the means of paying for the information. For example, one major point of information dissemination is the auto clubs, to which motorists subscribe in order to obtain the information. This implies that the motorist places a value on being able to receive such information (as well as the other services offered). Those that do not subscribe to this or any other service essentially indicate that obtaining the information is not worth the cost. Another way of saying this is that information needs vary among individuals. What one person perceives as a need is not a need according to another person since he or she is unwilling to pay. The question then arises as to what extent a public agency should be involved in providing certain types of information. The approach to the concept for semidynamic information recognizes that, while DOT's may have responsibility for providing some minimum amount of information, much of the semi-dynamic information will be provided by private enterprise.



Concept for a Motorist Information System for Semidynamic Information

Figure 21

Another issue is distinguishing between pretrip and enroute information needs. In Figure 21, both pretrip and enroute needs have been addressed in the same overall concept. In many cases, the same mechanism addresses both pretrip and enroute needs. Telephone-based systems, for example, may be accessed prior to leaving home, at fixed locations along the route (e.g., pay phones) or with mobile phone systems where available. Likewise, printed materials can be obtained prior to the beginning of a long trip, but many of the same materials are available along the way. In this sense, each stop could define the end of a trip and the beginning of a new one.

The information consolidation and transmittal functions in the figure are directed toward four basic areas. The first is the telephone-based element, shown by the group of boxes on the left side of the figure. The consolidation element indicates the preparation of directories of services information at the local, regional, or even national level. Hard copy versions, equivalent to the telephone company's "yellow pages," would be available at home or pay phones. An audio version of the directory could also be developed for access from fixed or mobile phones. The caller would interact with voice-synthesized messages enabling him to select options by pushing the appropriate buttons until the desired information was accessed (e.g., price information on a nearby restaurant). Similarly, an electronic directory on services information could be developed. A memory module (e.g., a computer disk) containing pertinent parts of this directory could be leased or purchased for use at home or on a trip in conjunction with an in-vehicular computer. In essence, this would be the electronic version of a hard-copy directory which could be carried along with the user. The memory modules, when interfaced with the computer, would enable information to be queried as the trip progresses. It could be designed to display information on a milepost basis, so that the computer would tell the motorist what services or problems lie ahead. The motorist's current milepost and direction could be entered manually, or could even be relayed to the vehicle's computer by roadside "electronic" mileposts, or by vehicle location technology.

Another electronic approach is to make a data base available for access from a computer terminal via the telephone system, using either a fixed-base or mobile telephone. The data base would be queried for information desired either pretrip or enroute.

A third approach would involve the use of induction/low power radiation technology to transmit data to a moving vehicle-equipped with an in-vehicular computer at selected locations on the highway. In essence, this is a form of "electronic HAR," in that data are transmitted digitally rather than in aural forms and are captured and stored by an on-board computer. The information can be displayed immediately or at some later time more convenient to the motorist. The on-board computer could also be capable of selectively capturing data or of automatically displaying data which the computer was previously programmed to select. A scenario could also be conceived in which information is transmitted via satellite in response to a motorist query and vehicular locational information. Although these concepts are not currently implementable and are not low-cost, they are included in the concept as potentially feasible system components which may become affordable in some future year.

Another implementable option included in the electronic directory category is the use of terminals located in rest areas, information centers, rental car agencies and other locations which contain information on motorist services, attractions, etc.

Terminals could contain a wide variety of information accessible through a menu-driven selection process. Such systems are beginning to be used more commonly, but usually for information which changes infrequently. Information which changed frequently would be most effectively updated using a connection to a central computer, which would download new information periodically. Information which changed less often could be updated using portable memory modules which would be created at the consolidation center (usually a private advertising firm) and physically interfaced with the terminal.

Another component of the system addressing semidynamic information involves the continued use of information centers. Such centers will continue to play a role in providing certain types of motorist information. Manned centers are more appropriate for locations with higher visitor volumes and in conjunction with attractions of various sorts. Unmanned centers with maps, information brochures, and possibly electronic terminals, as discussed above, provide a lower cost alternative and would be appropriate at rest areas, approaches to cities or entry points to States on the primary highway system. Efforts might be directed toward enhancing unmanned information centers. Although vandalism has been somewhat of a problem in the past, vending machines with appropriate maps and guides would be the most logical method of dispensing printed information so as to recover some of the costs of operation.

One of the more promising concepts implementable in the near term but which may have to overcome some institutional barriers is the more extensive use of highway advisory radio in providing services information to the public. This medium has the advantages that it can transmit substantially more information than can be transmitted by highway signs, does not clutter the environment, and is able to target the information to the most likely users. Typical locations for consideration of HAR stations would be approaches to major attractions, transportation terminals, large cities, and certain highway interchanges. There is a need to determine to what extent this medium can be used for services information and, if this is possible, how the content of the transmitted information should be regulated. A reexamination of FCC rules regarding HAR use for these purposes is needed.

A final component of the semidynamic system involves guide book type materials and travel counseling traditionally provided by auto clubs, oil companies and other publishers. This is information more of a pretrip nature, but as discussed previously, can also be obtained enroute. This material will continue to play a major role in providing semi-dynamic information in the future and is currently one of the lower cost means of providing that information. However, these means are not as effective and thorough as some others, and as the relative cost of other methods declines, traditional methods may be gradually replaced.

Whether the other options discussed for semidynamic information are practical enough and of low enough cost to be implementable will be determined by the market for the information. If there appears to be a market, it is likely that the private sector will eventually pick up on the idea. Highway agencies and the FCC will need to be involved where it is necessary to protect the public interest, such as how to control the use of HAR, should it become a permissible medium for services information.

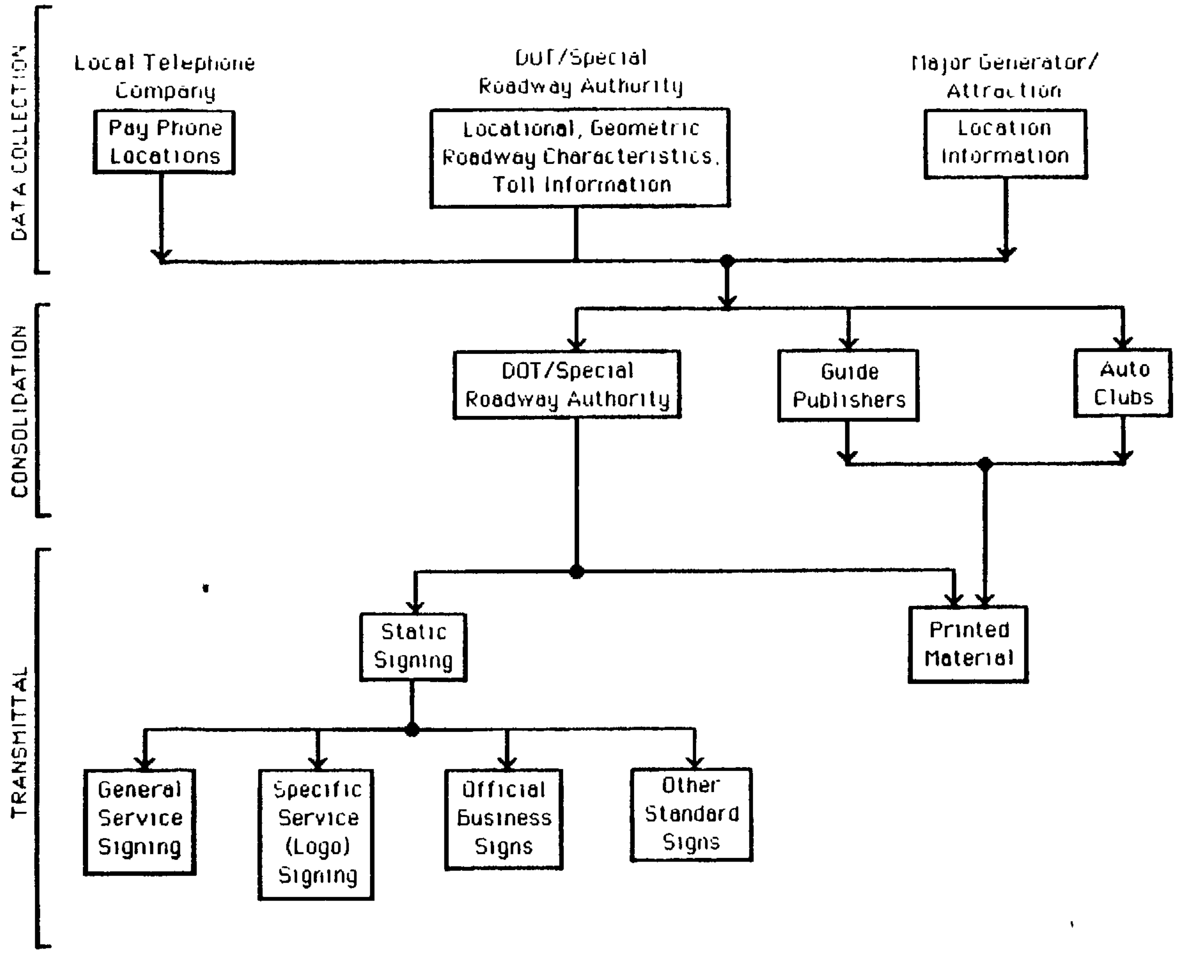
Concept for Static Information

Chapter 1 discussed the principle that the government should be responsible for assuring that the minimum information necessary for highway travel be provided. In essence, the higher priority motorist needs discussed in Chapter 1 could be said to be the more necessary information and thus are needs to which the government should pay particular attention. A review of those priorities indicate that a number of the needs included in the static information category are of high priority. Fortunately, because static information changes relatively rarely, these needs can generally be met with highway signing, both an effective and low-cost method of communication. This is not to say that other methods of information transmittal cannot be used to address static needs. However, other methods will find it difficult to compete with static signing on a cost basis.

Figure 22 illustrates the concept of providing static information. As stated in Chapter 3, the data collection and consolidation functions for-static information involve quite different processes than for dynamic and semidynamic information. It includes a process of field inventory, public comment, coordination with private firms, design review, and sometimes political approval, items which are difficult to adequately show in a figure. The auto clubs, oil companies, and other publishers of guides, maps and other printed material are also involved, as some static information is included in these materials.

The various types of signs used to supply information to the motorist have been described previously in Chapter 3. The general service signing, specific service signing and official business signing are oriented primarily toward location of services, with the official business signing providing the most detail of the three. The Task Force to Restudy Directional and Informational Signing recommended the expanded use of official business signs on highways other than freeways in 1979, and this would substantially improve one's ability to locate certain services. However, they would not fulfill the need for having additional information of a semi-dynamic nature on costs and other details regarding the facilities. Emphasis should be placed on these and specific services signs for providing locational information on travel services. Additional authority and guidelines will be necessary for more widespread implementation of official business signing.

The need for information on permanent roadway conditions (geometrics) is one of the highest, if not the highest priority need. This need is addressed primarily through the regulatory and warning signs, and this method is expected to continue to fulfill the need into the forseeable future. There are other means of providing this information, including audio signing and electronic transmission of messages to an in-vehicular display. However, any additional effectiveness achieved by these methods is highly unlikely to justify the costs involved.



Concept for a Motorist Information System for Static Information

Figure 22

5. RECOMMENDATIONS AND IMPLEMENTATION PLAN

The original objective of this study was to "develop a low-cost, practical motorist information system." One could possibly have envisioned a central agency which would have gathered and disseminated all the information a motorist would need in the course of making any trip which could possibly be taken. A high-technology device might have also been conceived which would end all motorist frustration by providing the information at the precise times and places needed.

As much as it would be desirable for the answer to be that simple and that clear, it is evident from the investigations in this study that the complex highway-driver-vehicle environment does not lend itself to solutions which are that simple. Rather, a multifaceted approach is necessary in which a variety of public and private groups will have responsibility and a variety of methods will be used in providing information to the motorist. The various components of these approaches have been categorized into the four basic concepts illustrated earlier in Chapter 4.

The multifaceted approach, while not constrained in its development by prior thinking or research, is in keeping with prior FHWA emphases, that is, maintaining flexibility to account for differences in needs among geographic areas and social structures and minimizing the governmental cost while assuring the fulfillment of certain basic motorist information needs. It was found during the course of the study that six principles outlined by the Task Force to Restudy Directional and Information Signing (quoted in Chapter 1 of this report) were true not only for signing systems but for all other types of motorist information systems as well. Three of those principles - multi-media, incremental, and cooperative - were particularly relevant in light of the continuing technological improvements in the electronics and communications industries and of the need for involvement by the private sector.

This summary provides an overview of the findings of the study in several sections.

- Overview of the Study Process
- Recommended Motorist Information System Concepts
- Summary of the Case Study
- Identification of the Roles of FHWA, Other Public Agencies and the Private Sector
- Implementation Considerations
- Research Needs

OVERVIEW OF THE STUDY PROCESS

Prior to discussing the specific recommendations and findings of the study, a brief review of the study process and of the basic structure of information concepts is presented. The study began with the identification of motorist information needs. Three basic classes of information were identified as being within the scope of the study. These information types were based on the time-dependent nature of certain information needs, which could be logically grouped into three basic categories:

- Dynamic information.
- Semi-dynamic information.
- Static information.

Dynamic information includes information which changes frequently and often influences a large group of users. This is primarily traffic-related information dealing with delays and congestion produced by traffic incidents, construction, and other factors. Dynamic information will be of little use to the motorist unless it is accurate and received in a timely fashion (e.g., alternate routing) so that appropriate action can be taken by the motorist.

Semidynamic information primarily relates to motorist services, such as gas, food, lodging, and attractions information. The desire is to not only know something of the presence and location of such facilities, but also much more detailed information (e.g., cost, credit card acceptance, etc.) enabling the motorist to make a more informed decision. Semidynamic information changes occasionally, but the changes are often refinements or minor modifications to the overall information. Because of the differences in the time dependency of the information, dynamic and semidynamic require quite different approaches to data collection and consolidation,

Static information refers to information which changes very infrequently, but generally affects a broad group of motorists. Knowledge of the highway geometry (e.g., curve ahead) and the knowledge of how to reach emergency services would be two examples of static information.

Following the analysis of motorist needs, a review of existing and potential motorist information system components was conducted. It was found that motorist information systems can be functionally described in terms of three basic activities. These include:

- Collecting data.
- Consolidating and processing the data.
- Actual transmittal of the information to the motorist.

The review of existing systems and development of alternative MIS concepts was structured around these functional areas. The range of data collection, consolidation and transmittal components were then evaluated, and the most promising components were packaged into conceptual systems (presented in Chapter 4). The conceptual systems were oriented around the three classes of information (dynamic, semi-dynamic and static). The case study (included in a separate volume as Appendix B) illustrates how one of the concepts would be implemented in a local area.

RECOMMENDED MOTORIST INFORMATION SYSTEM CONCEPTS

A motorist information concept, as defined in this study, consists of a coordinated structure of data collection, consolidation, and transmittal components designed to meet specific motorist information needs. Four of these concepts were developed in this study, specifically addressing the dynamic, semidynamic, and static information needs. Two concepts were developed to address dynamic information, one for urban areas and another for rural and small urban areas. Semidynamic and static information were addressed by one concept each. The following sections summarize the key features of each concept. The concepts are shown functionally in Chapter 4.

- The concept for dynamic information in urban areas is oriented around a private traffic information service as the consolidation center. Freeway surveillance and control systems may also serve as an intermediate consolidation center or even as the primary center if coverage of an urban area with surveillance systems is complete. Key data sources will continue to be air and ground-based observers, with the possibility of expanding the use of volunteer commuter contacts as a low-cost option. A wide range of transmittal media are possible. Traditional AM/FM radio broadcasting will continue to be used, and some possible enhancements of this medium are possible through the zoning of traffic information by participating radio stations and a more systematic scheduling of traffic reports. However, to make significant long-term improvements in the timeliness of the information, a dedicated traffic information radio channel will be needed. The most promising source for a dedicated radio medium is an FM SCA channel (see Chapter 3). The FM SCA channels were recently deregulated by the FCC, increasing the potential usefulness of this medium for purposes such as this; but special receivers will be required. Selected use of HAR and CB radio transmission at key locations are other low-cost transmittal methods to be considered in the near term.

- The consolidation operation for dynamic information in rural and small urban areas is designed around police operations, with possible assistance from State and local highway departments, depending on the institutional setting and allocation of responsibilities. The operation is designed to meet the sporadic needs for information which principally occur only during major incidents. Probable low-cost transmittal media include commercial radio, if available in that area, NOAA weather radio and mobile HAR or variable message sign units,

- In the concept for semidynamic information, multiple consolidation centers are identified (e.g., auto clubs, travel agencies and advertising firms), and a number of transmittal methods can be used. This information has high potential for application to electronic means, and a variety of electronic/computer-based methods are identified. However, most of these are not yet cost-effective in comparison with current methods (e.g. hard-copy travel guides). The data collection and consolidation process is likely to be largely a function of the private sector, with DOT's continuing to have some involvement in the provision of information at rest areas and other information centers.

- For static information, signs will continue to be the predominant means of communication. Continued emphasis should be placed on logo signing and official business signing.

In developing the concepts, an emphasis has been placed on the low-cost, practical aspects. In addition, however, it has been recognized that technologies which are not necessarily low in cost at this time may play a significant role in the system of the future as the relative cost declines. This does not mean that anyone should immediately make an effort to provide this technology. Rather, these ideas have been included in order to better indicate how these future technologies will eventually fit into the overall system.

Specific considerations given to the low-cost, practical aspects of the system are as follows.

- Allowing the private sector to take the initiative in areas where there is a self-sustaining: market for the information. There are many areas within the recommended concepts where this can be done. The two areas where the most government involvement is required include the provision of traffic information in rural areas during major incidents (there is not enough of a market for the information in a rural area to support a commercial operation) and the provision of various levels of signing (necessary because of the DOT's ownership of and jurisdiction over the highway right-of-way).

- Working with and expanding upon systems which are already functioning well. An effort has been made to identify and build upon methods which either have already been proven or which have been shown to have high potential for success. For example, private traffic information services have been shown to serve as a viable, low-cost method of providing traffic information and are being increasingly implemented across the country. A plan recommending a course contrary to this relatively effective, low-cost (to the government) method would, in all likelihood, be shelved very quickly. However, significant enhancements can be built upon this basic structure to improve the information provided.

- Provision for user charges, particularly where there is no apparent obligation on the part of government to provide the information; in other words, the information is desired but not necessary.

As stated previously, there is no single information system which is ideal for all conditions. Rather, the information concepts identified permit components to be selected, as appropriate, for the conditions in which they are to be applied. Thus, a city which has an extensive surveillance and control system may take a different approach to collecting, consolidating, and transmitting traffic information from a city which currently has less reliance on surveillance and control. The information system concepts are also incremental in that old technology can be phased out and new technology can be phased in as it becomes more cost-effective. Chapter 4 discusses the various concepts in detail.

There are also various institutional issues that need resolution before certain ideas can move forward. Several involve frequency allocation while others are more of a coordination nature. Several of these issues are as follows:

- Possibility of an expanded role for HAR in providing more information on motorist services than has been allowed in the past.

- Clarification of the possible uses of mobile HAR.

- Possible use of NOAA weather radio as a vehicle for disseminating a greater amount of traffic and roadway information, (coordination will be necessary with police and highway agencies).

- Possible use of CB radio as a more formal information dissemination mechanism needs to be investigated from an institutional as well as a practical perspective.

- Ways to promote police participation in the provision of traffic information and methods of overall interagency coordination need to be investigated.

SUMMARY OF THE CASE STUDY

The four motorist information system concepts discussed above are generic in nature, that is, they constitute a basic framework around which information systems can be designed and implemented at the local level. However, the relative costs and effectiveness of the information systems cannot be specifically established until the candidate systems are evaluated in the context of a specific geographic setting. An evaluation of the systems for a specific set of conditions enables more rigorous costing to be performed, specific estimates of penetration into the motoring public to be made, and approximations of the benefits to be developed.

To provide the context for the further evaluation of the concepts, a case study was conducted by applying the concept for dynamic information in urban areas to a specific city, in this case, the Washington, D.C. metropolitan area. The case study includes two aspects. First, a systematic planning process for designing and implementing a motorist information system is presented. This includes a series of steps which local agencies could follow which would result in the improvement of existing motorist information systems and the implementation of new information system components, as appropriate. The second aspect of the case study is an evaluation of data collection, consolidation, and transmittal alternatives specifically for the Washington metropolitan area. Although certain aspects of the results may be unique to Washington, there are a number of significant findings which have implications on motorist information systems in other urban areas, The results of the case study are contained in Appendix B of this report, available in a separately bound volume.

The preferred system for Washington, D.C. would include the following:

- A private traffic information service acting as the consolidation center, with radio stations and public agencies subscribing to their services for information to be provided.

- Data collection primarily through employed aerial and ground-based observers, supplemented by volunteer commuter contacts equipped with mobile telephones or two-way radios; an experimental program of obtaining information through the transit agency via trained bus drivers in the field; selected CB radio monitoring stations; and the provision of an electronic information system linking police and highway agencies with the consolidation center.

- In the near-term, enhancement of the existing AM/FM radio network could be achieved through more organized zoning and scheduling of the reports and a higher degree of cooperation between local agencies and the media providing traffic information. The preferred long-term system is a dedicated traffic channel, using FM SCA technology, with receivers in the vehicles capable of preempting regular radio or cassette tape listening with a zone-oriented traffic report. The major cost of this system is the in-vehicular receiver, and if the cost of the receiver can be kept down, the system should be quite attractive to the motoring public. Cost estimates indicate that the receiver could be made available for $100 or less. The dedicated radio channel approach was found to be superior to a system of remote digital broadcast stations scattered throughout the highway network from the perspective of both cost and information quality. Although the same information could be broadcast in digital form for reception by in-vehicular computers, voice broadcast is preferred because of the human factors problems associated with in-vehicular displays and the higher cost of digital data reception and display.

OVERVIEW OF THE ROLES OF FHWA, OTHER PUBLIC AGENCIES, AND THE PRIVATE SECTOR

A number of comments have already been made regarding the roles of various agencies in the process of implementing and operating motorist information systems. This section briefly highlights and summarizes those potential roles.

Potential Federal Highway Administration Role

The Federal Highway Administration's role in the provision of motorist information has already been discussed in general terms. As part of its administration of the highway-related transportation functions of the federal government, it is involved in funding programs, monitoring State and local use of those funds, providing technical assistance and other related duties. In relation to the motorist information area, the following could be conceived as potential roles of FHWA.

- Research, including the preparation of syntheses, experimentation with devices and techniques, and performance of demonstration projects which will lead to improved practical experience transferable to the eventual providers of the information. Particular emphasis is placed in the implementation plan (next section) on a number of demonstration projects to test the feasibility of selected motorist information system components. Demonstration projects are recommended for testing the feasibility of: using the FM SCA channels for disseminating traffic information; disseminating traffic information over CB radio; and collecting traffic information through an extensive network of volunteer commuters.

- Funding specific programs by which DOT's can directly provide motorist information. Existing funds are available for a variety of activities.

- Cooperative ventures with the private sector. There are several opportunities for FHWA to be involved as a catalyst to initiate more private sector activities in this area. This could involve demonstration projects which might be picked up by the private sector, or serving as an information source, making-needs known where there is likelihood that the private sector might play a role in meeting those needs.

- Providing guidelines, procedures, and associated training or informational materials to give guidance to state and local agencies involved in implementing information systems.

- Provision of standards, regulation and monitoring activities under FHWA's jurisdiction. Care should be exercised in not expanding this role into areas primarily being addressed by the private sector, unless the lack of such standards threatens the safety of the motoring community.

The above represents a relatively active role on the part of FHWA. It could also be argued that FHWA should take on a relatively passive operational role in which the market will largely dictate the direction taken and the amount of information provided. Reasoning behind this approach would be that the motoring public and the private sector will determine on its own which information is truly necessary and how it should be provided. One of the risks of pursuing a passive role is that a lack of uniformity could result. Another possibility is that a system could develop which does not provide the motorist with comprehensive information. There is some latitude in the concepts as to how intensively FHWA would need to be involved. However, an active involvement by FHWA is important at the current stage of development, as both public agencies and private industry are in need of information about motorist information technologies and direction as to how the technologies can be applied in various institutional, geographic, and highway system environments.

Role of Local and State Highway Agencies

Because the provision of motorist information is an integral part of providing transportation services to the public, it is legitimate that highway agencies should be expected to participate in the process of providing that information. In addition, there are significant benefits which accrue to the highway agency and to the public in terms of better utilization of the highway network, reduced delays and reduced motorist frustration. There has been a significant lack of cooperation between highway agencies and the private providers of traffic information, and the motorist has suffered substantially as a result. Several of the possible areas of involvement by highway agencies are listed below.

- Develop an urban area plan to improve the provision of traffic information, in conjunction with other local agencies. The case study (Appendix B in a separate volume) presents a planning process which a local agency might use to initiate an effort aimed at improving motorist information in the region represented. Although the highway agency may not ultimately be responsible for implementation, it may be the most logical agency to initiate the process.

- Initiating a higher degree of coordination among local agencies for the provision of traffic information, including communications links among agencies; coordination of highway signing with the needs of those doing traffic reporting; and working with the media to develop reasonable traffic zone systems and reporting schedules.

- Continued provision of services signing in urban and rural areas.

- Direct implementation of certain aspects of the motorist information system (possible methods include strategically placed HAR stations, telephone information system, or CB radio based information system. The DOT's could provide the hardware and subscribe to the private traffic information service to provide timely information).

- Preparation of diversion plans which can be used by traffic reporters in the event of a need for major diversion (signing supplements may be necessary to support this system).

- Contracting with information providers where necessary to assure the provision of appropriate information.

- Maintaining or contracting for information displays at rest areas and other state or locally sponsored information centers.

Role of Police Agencies

Police have a unique role in both the provision of traffic control and motorist information. As previously stated, reporting on traffic conditions is not viewed to be one of their primary functions, but they are, nevertheless, in the best position to provide information under certain conditions. While it may not be possible to dramatically increase the emphasis on reporting traffic information by officers in the field, due to the priorities of protecting life and property, it should be possible for police to more effectively compile and disseminate information on traffic which is already known. Thus, it is recommended that other agencies work with police to develop a more systematic method of status reports on traffic conditions (especially incident status) so that this information can be disseminated to motorists in timely fashion. An electronic system of interconnected displays is ideally suited to this purpose, and could lead to efficiencies in record keeping in other areas not related to traffic.

A second area of involvement by police agencies is in rural and small urban areas where recurrent traffic congestion is not a problem, but occasional major incidents require the provision of traffic information on delays and possible diversion. Again, police are in a key position to provide that information, and methods are available by which it can be disseminated. Highway agencies may need to take the initiative to develop cooperative procedures for dealing with traffic occurrences in rural and small urban areas.

Role of the Private Sector

The private sector will continue to play a varied role in the provision of motorist information. Although, in the end, the 'market must dictate what is possible for the private sector to do, the following are suggestions as to where the private sector most readily fits into the process.

- For dynamic information, expanding the coverage of private traffic services to more cities. In addition, provisions need to be made for the motorist to be provided with traffic reports more focussed on specific zones and corridors so that the timeliness and level of detail of information available to the motorist will be maximized. Specific techniques for doing this have been discussed in the report.

- For semidynamic information, continuation of technological advances which will lead to improvements in services information. Some of the areas include the following:

  - Creation of user-oriented data bases of services information (information listed in Chapters 2 and 3 should be considered for inclusion). Thought should be given to how the data bases would be organized to be of most use (e.g., referenced to mileposts, interchange numbers, etc.) and which should be the primary parameters on which the information may be sorted.

  - Continued publication of maps, guide and brochures, with emphasis on user orientation.

  - Development of cheaper electronic means for transmitting data to a moving vehicle.

  - Development of memory modules which can be used in the place of printed materials for use on trips.

  - Development of in-vehicular computer technology which will enable the motorist to use electronic data bases for travel information and navigation.

IMPLEMENTATION CONSIDERATIONS

Of the concepts presented in Chapter 4, some have already been demonstrated to be viable methods and techniques for disseminating motorist information. Others are technologically feasible but have simply not been demonstrated. Others are also technologically feasible and practical but are being held up by institutional problems or delays. Still another group has considerable development to go through before they can be considered technologically feasible. Thus, an implementation strategy would have to consider both the technological aspects and institutional aspects of the process.

Of the technological issues, many have been or are being addressed by private industry, primarily the automobile and the communications industries. There is no need to duplicate these efforts. Rather, attention should be focussed on how the available, or soon to be available, technologies can be put to use for motorist information systems. For FHWA, this implies an emphasis on demonstrations of systems supporting the new technology or supporting certain aspects of current technology which were never adequately'tested before.

Tables 16, 17, and 18 summarize a series of activities needed to implement the motorist information system concepts in Figures 17 to 22. Each of the three tables directly correspond to the three specific dynamic and semi-dynamic concepts shown in the figures, including concepts for 1) dynamic information in urban areas; 2) dynamic information in rural and small urban areas; and 3) semi-dynamic information. Implementation activities for static information have already been summarized in the text.

Tables 16, 17, and 18 are structured into three standard classifications (data collection, consolidation, and transmittal); and within these classifications, the various system components are listed. For each system component, appropriate implementation activities are specified. Some components may have multiple implementation activities, while others are already in operation and are therefore in little need of additional implementation effort. However, some degree of implementation action is specified for most of the system components, if only the improvement of existing methods. It is important to note that, in some cases, the implementation activity represents a direction which is already planned; and there is already progress in that area. In these cases, the implementation activities are simply restatements of what is already being done.

For each implementation activity, the agency responsibilities are specified for conducting that activity. Although some of the activities are the direct responsibility of FHWA and the State and local departments of transportation, many of the responsibilities logically fall into the realm of private industry. Although there can be no assurance that private industry will implement every aspect of the MIS concepts, they are proceeding in that general direction. If FHWA determines that implementing these concepts is in the interest of the motoring public, it should then be prepared to accommodate and assist private enterprise in those pursuits which further the implementation of the systems.

For each implementation activity, a priority and time frame are also assigned. A high priority action is considered a very important activity requiring immediate attention. A low priority activity is one which will not likely have a significant impact on the overall system operation, but will at least contribute to the system. The time frame refers to the period of time in which the component should be or is likely to be implemented. Time frames are defined as follows: near term - within the next 3 years; mid-term - next 3 to 10 years; long term - over 10 years. As indicated in the tables, many of the implementation activities- can be undertaken in the near term. Those components requiring a great deal of technological development (or cost reduction to satisfy the low-cost criterion) are targeted for the mid- and long-term time frames.

The last column in each table indicates some of the benefits to be derived by carrying out the indicated implementation activity. These benefits relate to the original goals established for the system in Chapter 1. Because it is not possible to quantify most of the benefits, they are expressed more in general terms.

An additional note regarding the implementation strategy involves the matter of sequencingof activities or their dependence on one another. Actually, most of the implementation activities are not highly dependent on one another, and the sequencing of activities is therefore not critical. The system can exist, as long as the basic data

Table 16. Implementation Program for MIS's for Dynamic Information in Urban Areas

Components	Implementation Activity	Responsibility	Priority	Time Frame	Benefits
Data Collection					
Police departments	1) Develop system requirements functional design for interagency communications system 2) Implement electronic connections between pohce departments and consolidation centers 3) Encourage greater mvolvement by police in providing trafftc information	1) FHWA, DOT's, police and emergency services 2) Police departments establish system. Connections paid for individually by users 3) Police, DOT's FHWA	High Medium High	Near term Near term Near term term	Improved agency info, both routine and emergency. Improved agency efficiency
DOT	I) Implement electronic connections between DOT's and consolidation center 2) Encourage greater involvement by DOT's in providing traffic information	1) DOT's establish system. Connections paid for individually 2) DOT's, FHWA	Medium	Near term	Improved agency information and efficiency
Surveillance and control systems	1) Continue implementation of S&C systems in congested corridors 2) Provide connections with other consolidation centers 3) Enhance computer graphics capabilities 4) Improved use of arterial/network control systems for traffic information	1) DOT's, supported by FHWA 2) DOT's, private traffic services 3) FHWA, DOT's 4) FHWA, DOT's	High High Medium Medium	Near to mid-term Near to mid-term Near to mid-term Near term	Better use of extensive existing S & C info- Improved timeliness and quality of reports
CB Radio monitoring	1) Initiate demonstration project (formal traffic information reporting channel) 2) Implement additional CB monitoring systems, pending results of demo	1) FHWA 2) Private traffic services	Low Low	Near term Near term	Good low-cost means of providing timely rnfo if quality is acceptable
Employed air or ground-based observers	1) Employ observers as needed for individual systems	2) Private traffic services	High	Near term	Best method for data collection and validation
Commuter contacts	1) Initiate demonstration prolect using mobile phone-based communication 2) Develop and implement strategy for using commuter contacts	1) FHWA 2) Private traffic service	High High	Near term Near term	Lower cost for collecting high-quality traffic data
Consolidation					
Consolidation Center	1) Expand private traffic service operations to other urban areas 2) Develop improved computer graphics formats 3) Explore possibilities of contracting for PTS's where market will not completely support private service	1) Private trafftc service 2) FHWA/private traffic service 3) FHWA, DOT's	High Medium Low	Near term Mid-term Near term	Improved efficiency of screening, processing and disseminating traffic rnfo
Transmittal Media					
Telephone trafftc information	1) Initiate demonstration project to provide telephone traffic information	1) FHWA	High	Near term	More timely info, accessible upon user demand

Table 16. Implementation Program for MIS for Dynamic Information in Urban Areas (Cont'd)

Components	Activity	Responsibility	Priority	Time Frame	Benefits
	2) Implement additional telephone informatmn systems, pending results of demonstration 3) Develop multi-line telephone recording and playback systems which are lower cost	2) Private firms 3) Communications industry	Medium Medium	Near term Near term	
Mobile telephone (cellular, PRCS, etc.)	1) Continue expansion of mobile systems	1) Communications Industry	High	Near to mid-term	Enables info to be obtained on demand
HAR	1) Contrnue expansion and improvement of HAR systems at appropriate locations 2) Examine potential for mobile HAR 3) Position papr on FCC rule changes to promote HAR use	1) DOT's, supported by FHWA 2) FHVA 3) FHWA	Medium Medium High	Near to mid-term Near term Near term	improved information at key motorist decision points
b-r-vehicular computers	1) Perform functional analysis of in-vehicular computer systems 2) Continue development of in-vehicular computer technology 3) Research human factors/Safety issues re: in-vehicular computers 4) Develop Support systems for transmission of digital data to movrng vehicles	1) FHWA 2) Auto manufacturers, electronics industry 3) Auto manufacturers, FHWA 4) FHWA, electronics industry	High High High High	Near term Mid-term Near term Mid-term	Will provide more flexible information system when cost becomes reasonable
AHAR	1) Look for opportunrtres to use AHAR but no widespread implementation. Build AHAR capability into Selected HAR stations	1) FHWA	Low	Long term	improved info at key decision points
Traffic info over formalized CB channel	1) Initiate demonstration project to provide traffic info over CB radio 2) Implement CB-based info systems, pending results of demo	1) FHWA 2) DOT's supported by FHWA	Medium Medium	Near term Mid-term	Low cost method of info dissemination
AM/FM Radio	1) Continue radio broadcast of traffic information. Improve focussing on information, where possible.	1) Radio stations, private traffic services	High	Near term	Better use of existing low cost method
Radio broadcast pre-emption technology (ARI, FM SCA)	1) Continue development of existing systems 2) Initiate demonstration project to provide traffic info over FM SCA channels	I) Private firms 2) FHWA	Medium Medium	Near term Near term	Improved timeliness and quality of info at low cost

Table 17. Implementation Program for MIS's for Dynamic Information in Rural and Small Urban Areas

Components	Implementation Activity	Responsibility	Priority	Time Frame	Benefit
Data Collection CB Radio	1) Expand monitoring of CB radio in rural/small urban areas in heavily travelled corridors	1) Police	Medium	Near term	Improved info timeliness and quality
Police/DOT communi-cations capability	1) Implement electronic communtcatims where feasible and economical	1) Police, DOT's, radio stations	Medium	Near term	Improved inter-agency info
Consolidation Use of police depts. as consolidation centers	1) Resolve institutimal issues limiting police involvement in providing traffic information 2) Establish structure for statewide traffic informatrm reporting	1) Police/DOT's 2) Police	High Medium	Near term Near term	Better traffic rnfo in rural areas with minimal added personnel cost
Transmrttal Media NOAA Weather Radio	1) Conduct demonstration program to broadcast traffic info over NOAA radio channels 2) Make arrangements to broadcast selected traffic information over NOAA radro channels 3) Expand use of retransmissrm of NOAA broadcasts over HAR	1) FHWA. NOAA 2) FHWA, NOAA, DOT's, police 3) FHWA, NOAA, DOT's, police	High Medium Medium	Near term Near term Near term	More detailed traffic info using existing system. Low cost receivers
HAR/AHAR	Same as HAR/AHAR in Table 15				
Traffic info. over formalized CB radro channel	Same as in Table 15				
Telephone traffic informatrm	1) Implement telephone traffic information service if mobile telephmes become prevalent in rural/small urban areas	1) FHWA, private firms, communications industry	Low	Long term	Can obtain info on demand

Table 18. Implementation Program for MIS's for Semidynamic Information

Components	Implementation Activity	Responsibility	Priority	Time Frame	Benefits
Data Collection and Consolidation					
Data base development by private firms	1) Perform functional analysts of in-vehicular computer systems and motorist needs 2) Develop recorded "audio directory" data base 3) Develop guidelines and regulations governing provision of services information over HAR 4) Develop computerized data bases on services information (for several possible applications)	1) FHWA 2) Telephone Co./private frrm 3) FHWA, FCC 4) Auto clubs, private advertising/computer firms	High Medium High Medium	Near term Near to mid-term Near term Mid to long term	More comprehensive, accessible information on motorist services
DOT's	1) Enhance communication between DOT's and private firms re: detour and construction info.	1) Private firms/DOT' s	Medium	Near term	More timely, accurate construction info
Mobile telephone (cellular. PRCS, etc.)	1) Continue expansion of mobile systems	1) Communications industry	High	Near to mid-term	Improved flexibility in info access
In-vehicular displays	1) Contmue development of in-vehicular computer technology 2) Examine market potential for provision of services information through in-vehicular computers	1) Auto manufacturers, electronics industry 2) FHWA, private Industry	High High	Mid-term Near term	Improved method of accessing and storing info
HAR	1) Install HAR at appropriate locations to provide services information, if permissible	1) Private advertising firms, FHWA, FCC, DOT's	Medium	Near term	More comprehensive info on services
Transmittal					
Publications	1) Contmue improvements in existing publications and motorist information services	1) Auto clubs, travel agencies, etc.	High	Near term	Continued low-cost method

collection, consolidation, and transmittal functions are present; and new components can be phased in and old ones phased out as technological or institutional advancements are made. Once the systems are developed at the local level, however, the implementation plan becomes much more specific; and a time schedule of implementation activities can be specified. The case study in Appendix B provides a sample local implementation plan for a specific series of motorist information improvements.

RESEARCH NEEDS

Table 19 summarizes a number of the technological and institutional issues in the form of research needs which could be considered by FHWA. The table indicates the subject of the study, the scope of activities which might be considered in such a study and a statement of the need which justifies the study.

A number of the needs address implementation concerns specified previously. For example, the establishment of a telephone traffic information service, although it has been tested in several areas, has not been examined in the context of a comprehensive traffic information system as proposed here. The success of such an operation is highly dependent on the timeliness and quality of information provided. Therefore, this component of the system should be thoroughly tested as part of an overall system which provides quality information. A demonstration of such a system would not only determine whether it is viable, but would also indicate procedures and guidelines to be used by agencies considering the establishment such a service. A number of other technical areas have been identified for possible demonstration in conjunction with the overall system. Discussions with the automotive and communications industries would also be appropriate to make sure that the information needs of the motorist were being addressed properly in the design of various systems.

FHWA's role in addressing some of the institutional issues will require a different approach from that used in addressing technological problems. If FHWA sees a particular institutional or legal question holding up progress, discussions with the appropriate officials and/or testimony at appropriate hearings would need to be made. In some cases the preparation of position papers would be in order.

During the course of demonstrating and-evaluating the effectiveness of various MIS concepts, FHWA will need to frequently reassess the status of technological development and confirm or modify their direction accordingly. For example, changes in FCC rulings or introduction of new products could significantly affect the direction that should be taken and the allocation of resources.

Table 19. Potential Research Needs for Motorist Information

Research Topic	Scope	Justification
Area 1. Data collection and consolidation		
1. Use of regular commuters in gathering traffic information	Demonstration project investigating effectiveness of using commuters to gather traffic information, coordinated with consolidation center. May involve cooperative effort with private traffic service. Would evaluate information quality and management/logistical problems.	Is a low-cost method with high potential for implementation in medium-to large urban areas. Little is known about potential problems. Guidelines are needed.
2. Monitoring of CB radio to obtain traffic information	Synthesis and possible demonstration project. Would review experience with CB monitoring specifically for traffic information and prepare guidelines for others.	Success has been achieved with such systems, but procedures for setting up and operating system have not been well documented.
3. Study of functional requirements for in-vehicular computer systems	Would provide functional guidelines for future developments of in-vehicular computers, based on motorist needs. Would deal primarily with data base needs and interaction of motorist with computer.	Study is needed to ensure that computer systems will provide information needed in a useful form and will not interfere with driving task.
4. Improved methods for use of arterial/network traffic control systems for motorist information	Would investigate ways of using detection capabilities of surface street systems to enhance motorist information. Would investigate ways to generate meaningful performance measures and displays which could be interpreted by non-engineers.	Arterial/network control systems have significant detection capabilities. Ways need to be developed to use these capabilities as a low-cost source of traffic information.

Table 19. Potential Research Needs for Motorist Information (Cont'd)

Research Topic	Scope	Justification
Area 1. Data collection and consolidation (Cont'd)		
5. Guidelines for effective computer graphics formats for motorist information	Would study developments in computer graphics outputs from surveillance systems and data base management systems. Would provide guidelines for format and use of such systems for motorist information.	Computer graphics are being increasingly used. Synthesis of effective techniques and preparation of guidelines would be helpful.
Area 2. Information Transmission		
1. Establishment of telephone-based traffic information systems	Demonstration project to establish a zone-oriented system of traffic telephone numbers. Recorded traffic information would be supplied by private traffic service. Systems operation and costs would be evaluated and and guidelines prepared for application elsewhere.	There is a need to test a comprehensive approach to this system in light of technological advancements. Guidelines are needed to indicate best management and funding arrangements.
2. Establishment of CB radio-based traffic information system	Demonstration project to test and evaluate use of CB. Retransmission stations would be set up at strategic points and recorded traffic information would be provided and updated regularly.	This low-cost method has been discussed but never tried in a comprehensive way. Its effectiveness needs to be determined and guidelines prepared.
3. Use of NOAA weather radio for transmission of traffic information	Would involve a coordinating effort with NOAA. Traffic information could be provided for a sample of NOAA stations (primarily rural) and integrated into weather report. Experience would be evaluated and recommendations made.	NOAA radio would provide low-cost information medium. Experience with limited system needs to be gained before making further recommendations.

Table 19. Potential Research Needs for Motorist Information (Cont'd)

Research Topic	Scope	Justification
Area 2. Information Transmission (Cont'd)		
4. Use of mobile HAR at major incidents	Would involve experimentation with mobile HAR station for use at major incidents. At least two systems would be employed for a period of time, experience evaluated and guidelines prepared if system proves practical.	Means are needed to provide more extensive information to motorists at major incidents. This is one potentially practical low-cost method about which little is known.
5. Use of fixed alternate route signing in conjunction with motorist information systems	Would investigate ways of coordinating motorist information with low-cost alternate route signing. Findings from past experience would be summarized and recommendations for improvements made.	Reason for providing traffic information is to allow motorist to optimize route. Better alternate routing procedures are needed.
Area 3. Institutional and management issues		
1. Market potential for various aspects of motorist information systems	Examination of potential application and benefits of specific components of the motorist information system. Cost implications of a range of actions would be estimated.	Market studies are an effective tool for scoping out the potential impact of solutions. This will provide direction for effective use of funds in future programs.

Table 19. **Potential Research Needs for Motorist Information** (Cont'd)

Research Topic	Scope	Justification
Area 3. Institutional and management issues (Cont'd)		
2. Investigation of alternatives for interfacing public agency communications systems for MIS purposes	Would identify functional requirements for a system to interface information system among public agencies and consolidation centers. Requirements for inter-connection of electronic terminals and content of various reports would be investigated.	Better communications among agencies is needed for motorist informatkn and re-sponse to emergencies. This study would specify require-ments for such a system.
3. Use of HAR for providing services information	FCC regulations place limitations on HAR for providing services information. This effort would recommend changes to FCC rules and guidelines for HAR use to allow greater application of this method.	Method has high potential as low-cost means for supplementing services infor-mation. A thorough review of the status is needed.
4. Methods of public/private cooperation in providing motorist information	Would investigate opportunities for public/private cooperation. Emphasis would be placed on areas in which responsibilities could be assumed by the private sector while still providing effective information to the motorist.	A better definition of public/ private roles is needed in certain areas.

FOOTNOTES

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2. King, C.F. & Lunenfeld, H. "Development of Information Requirements and Transmission Techniques for Highway Users," NCHRP Report 123, Wash., D.C., Highway Research Board, 197 1, p. 239.

3. U.S. Department of Transportation "Options for Assuring Adequate Motorist Travel Information," Report of the Task Force to Restudy -Directional and Information Signing, Wash., D.C., US DOT, Mar. 1979, p.v.

4. King, G.F. & Wilkinson, M.R. Motorist Needs for Services Information on Interstate and Federal-Aid Primary Highways, Huntington Station, NY, KLD Associates, July 1982, p. 267.

5. Turnage, H.C., Highway Advisory Radio User's Guide, Alexandria, VA, Atlantic Research Corp., May 1981, p. 105.

6. Owen, J.R. & Urbanek, G.L. Alternative Surveillance Concepts and Methods for Freeway Incident Management, Wash., D.C., Peat, Marwick, Mitchell & Co., March 1978, 6 vols.

7. Fullerton, I.J., Kell, J.H. & E.A. Aiona, Jr., Motorist Aid Systems Study, State of the Art Report, San Francisco, CA, JHK & Associates, June 1976, vp.

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APPENDIX A

Evaluation Criteria Descriptions

CRITERIA FOR DATA COLLECTION COMPONENTS

1. Information currency: This is a measure of the amount of time lag between successive observations of conditions (including the time required to report those conditions to the consolidation to the consolidation center).

Ratings: 0 - Sufficient time lag to allow conditions to change substantially.
1 - Moderate time lag, conditions change slightly.
2 - Only a minimal time lag.

2. Reliability of source: This measures the ability of the source to give accurate information. This depends upon the source's training, primary responsibility, and interest in providing the information.

Ratings: 0 - The source cannot provide information of useful accuracy.
l - The information provided requires definitive verification.
2 - The information provided requires minimal verification.

3. Coverage of the source: This measures the ability of a source to be located where needed at a given time.

Ratings: 0 - Information can only be provided for a fixed point or very limited area.
l - Information can be provided for a moderate size area or only portions of a larger area.
2 - Information can be provided for an extensive area.

4. Communication with the source: This measures the dependability and quality of communication between the source and the consolidation center.

Ratings: 0 - Communication is dependable and of adequate quality less than 60 percent of the time.
l - Communication is dependable and of adequate quality between 60 and 90 percent of the time.
2 - Communication is dependable and of adequate quality more than 90 percent of the time.

5. Detail of the information available to the source: This is a measure of the amount of detail a source is in a position to know for a given situation or condition. For example, for dynamic information a good source would have knowledge of both the cause and effect of a problem. For semi-dynamic information, the source would have in-depth knowledge concerning the particular service **or** condition of interest.

Ratings: 0 - The detail of the information provided is low and is only slightly useful.
l - The detail of the information provided is moderate and can be useful through some further verification or inquiry.
2 - The detail of the information provided is high and is quite useful.

6. Institutional constraints: This is a measure of the extent that institutional barriers are likely to interfere with the use of the intended source.

Ratings: 0 - Major action is required by the potential source or others; unlikely to be resolved.
1 - Minor action is required by the potential source or others; probably resolved.
2 - There are no foreseeable barriers.

7. Near-term implementability: Given a decision to proceed, when could the data collection source be put into use.

Ratings: 0 - More than five years.
1 - One to five years.
2 - Within one year.

CRITERIA FOR CONSOLIDATION CENTERS

1. Quality of output: This is a measure of not only the effectiveness of the presentation in terms of the information provided and its format, but also the quality of the data employed and the consolidation process utilized. This depends on the currency and detail of the data, the reliability of the sources, and the degree of verification.

Ratings: 0 - The information provided would be of poor quality resulting in low credibility.
1 - The information provided would be of fair quality resulting in moderate credibility.
2 - The information provided would be of excellent quality resulting in high credibility.

2. Timeliness of output: This is a measure of the ability of the consolidating center to provide helpful information to the motorist at the time when it is needed.

Ratings: 0 - Information provided would be rarely helpful.
1 - Lnformation provided would be occasionally helpful.
2 - Information provided would be usually helpful.

3. Personnel Considerations: This is a measure of the degree of flexibility of the consolidation center in effectively hiring and managing personnel. It reflects the ability of the consolidation center to quickly obtain or replace the personnel required to fill the relatively specialized positions.

Ratings: 0 - Minimal flexibility.
1 - Moderate flexibility.
2 - Good flexibility.

4. Institutional constraints and near-term implementability: This is a measure of the extent to which institutional barriers are likely to interfere with the implementation and/or effective operation of the intended consolidation center (e.g., ability to obtain revenue through radio advertising). This would be the major determinant concerning the near-term implementability.

Ratings:
- 0 - Major institutional problems are likely to be encountered.
- 1 - Institutional problems are likely to be encountered but they will only moderately affect operation.
- 2 - There are no foreseeable institutional problems.

CRITERIA FOR TRANSMITTAL METHODS

1. Reliability: Reliability may involve either the equipment used to transmit and receive information, or the medium (e.g., radio waves, wireline network) through which the information passes. Roadside signs (including variable message signs properly maintained) would rank high as reliable media. So would standard broadcast media. CB on the other hand would rank low because of the high volume and probability of interference on the CB channels. Reliability can be expressed in terms of the percentage of intended recipients likely to actually receive a transmitted motorist information message. It is assumed for this purpose that the intended recipients have their equipment turned on (if required) and are in a position to receive the message.

Rating:
- 0 - Less than 90 percent of intended recipients are likely to receive a complete, uninterrupted message.
- 1 - The message will be received by 90 to 99 percent of intended recipients.
- 2 - Probability of reception is 99 percent or better.

2. Transmission delay: This characteristic is important if the medium is used to transmit time sensitive information such as delay causing traffic incidents.

Ratings:
- 0 - The medium cannot respond in less than one hour to a changed situation.
- 1 - The medium is capable of providing a minimal transmission delay, but access to the medium must be initiated by the user. This would apply to the public telephone network used to access the information source. Delay can occur between the occurrence of an incident and the motorist's request for information.
- 2 - The medium can automatically alert the motorist within minutes of the occurrence of an incident.

3. Information content: This is a measure of the amount of information that can be communicated to the motorist via the medium in question.

Ratings:
- 0 - The medium is suited only for concise messages of a few words. This is typical of roadside signs.
- 1 - The medium can readily provide aural messages of one minute or more in length, or visual messages of equivalent information content. This would be typical of radio traffic broadcasts.

2 - The medium can provide lengthy and detailed information such as might be provided by printed brochures or by a fully dedicated radio channel (e.g., weather radio).

4. Penetration into user groups: The percent of the affected motoring public making use of the transmission medium. A low cost motorist information system would aim for a high degree of participation.

Ratings: 0 - The penetration is likely to be limited to less than 50 percent of the motoring public.
1 - More than 50 percent, though perhaps less than -90 percent, of the motoring public would probably make use of the service.
2 - The penetration would probably exceed 90 percent.

5. User selectivity: This is a measure of the ability of a medium to limit the distribution of specific information to the users having a direct interest in it. This is in contrast to giving all information to everybody.

Ratings: 0 - Distribution cannot be limited to areas smaller than that encompassing a city or county (would apply to standard broadcast stations).
1 - Distribution can be restricted to zones or areas within a city or county.
2 - Distribution can be restricted to motorists heading in one direction along a specific roadway (would apply to all types of highway signs).

6. Legal/institutional constraints: This is a measure of the extent that legal or institutional barriers are likely to interfere with the use of the intended medium.

Ratings: 0 - Major action is required by the FCC state or local agencies, the outcome of which is uncertain.
1 - Routine licenses and/or clearances are required such as FCC authorizations or zoning permits for antenna sites.
2 - There are no foreseeable barriers.

7. Time frame available: Given a decision to, proceed, and considering the state of technology development, hardware availability, legal constraints, etc., when could the medium be put into use?

Rating: 0 - More than five years.
1 - One to five years.
2 - Within one year.