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An Exploration of the Market for Traffic Information

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Abstract

Since traffic information is indirectly priced and experiences significant economies-of-scale, it can not be described by the classic demand model normally used to explain most goods. Therefore, this report focuses on the derivation of a demand model that describes the supply and cost mechanisms influencing the market for traffic information. This study includes a discussion of the history of the market, its economies-of-scale, and its potential for future development. In addition, recent developments of value-added-resellers, the differences which exist in the marketing of their products, and some factors influencing their success in the market for traffic information will also be discussed. Several suggestions for both the commercial broadcast stations and the public agencies that aim to maximize the total benefits of traffic information are presented.

Keywords: Traffic Information, Information Broadcasting, Supply/Demand Modeling

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Executive Summary

The market for traffic information has grown considerably in the past 10 years. It is different from other goods for a number of reasons which include: (a) traffic information is not sold at a common destination; (b) traffic information is usually not sold directly to the media or commuters; and (c) significant economies-of-scale result from the large fixed costs necessary to gather the information. As a result of these unique characteristics, the classic economic model can not be used to determine the price or the amount of information which would be produced and consumed under competitive equilibrium.

In this study an attempt is made to derive a more accurate economic model that will provide a better understanding of the future benefits of traffic information. To do so, the history of traffic information as a marketable good is first described. Next, the formation and demise of earlier traffic information providers is described. Finally, the focus of this report shifts to the current primary traffic information providers and the direction the market has taken in recent years.

To gain an understanding of the direction of the market in recent years, an information provider's various costs and how they affect the amount of information disseminated are examined. In addition, the underlying economies-of-scope limiting the industry's competition are explored.

Subsequently, a proposed model that describes the demand for traffic reports by commercial broadcast stations is presented. It is shown that this model differs from the classic demand model. The proposed model is used to draw conclusions about monopolistic equilibrium, competitive equilibrium, and the position of the market today. In addition, from the perspective of both the commercial stations and local planning agencies, methods which enhance the public benefits of traffic information are explored.

In closing, several products offered by value-added-resellers and their marketability are discussed. A recount of the previous successes and failures of these products in the market is presented. In particular, the differences between the market for personalized products and the market for commercial broadcast information. Finally, the types of public policies that could be implemented to ensure the maximization of the societal benefits of traffic information are proposed.

1. INTRODUCTION

Traffic information systems are perceived by many as a method which can help to alleviate congestion. Recent advances in communications and transportation technology make it possible to bring traffic and transit information readily to the users and managers of the system. Information such as locations of traffic incidents, road conditions, and optimal routes are provided by Advanced Traveler Information Systems (ATIS) with the objective of influencing the traveler's decisions concerning mode, route choice, and departure time. Different types of information currently in development or in service include commercial broadcasts, route guidance systems, telephony, paging systems, and others. While there is considerable optimism regarding the benefits of these endeavors, there has been little rigorous inquiry into the effects of traffic information and its value.

1.1 Objective

In recent years there have been many ATIS efforts, such as the TravInfo System in the San Francisco Bay Area and the SmarTraveler operated in Boston. Work has been done to evaluate the feasibility of some technologies, but this has not contributed (nor was it the intention) to the justification of investments being made in traffic management. In order to validate the public sector's potential role as an information provider, it is first necessary to understand the behavior of private traffic information providers and the structure of the industry.

Very little has been written about traffic information providers and even less literature has been published about the structure of the industry; the only information gathered is usually printed in local newspapers. This study is an attempt to understand the structure and the behavior of the traffic information industry and how the industry works. The particular focus of this report is on the traffic reporting services available in the United States. The structure of the industry in Europe appears to be different from that in the U.S. References are made in regard to European operations when relevant.

The general public is usually unaware of the role traffic information providers play in supplying information to broadcast stations, since they remain anonymous when their product is disseminated. Information providers such as Metro Networks and Shadow Broadcast Services have the ability to influence a traveler's mode choice or route choice. For example, if a traffic report announces that the occurrence of an accident on a freeway has caused traffic to back up to a certain on-ramp, the traveler may avoid the traffic jam by taking an alternate route, departure time, or by canceling the trip altogether. Similarly, a traveler who planned to use public transit may instead choose to drive if a report announced that public transit was behind schedule.

Traffic information is different from most goods in that the cost to users is negligible and indirectly priced. Consumers are able to receive information when and where it is most convenient, provided they have access to a commercial radio. Reports can be reproduced and distributed at minimal cost, while no transportation cost is associated with consumption. Commuters receive traffic information without paying the radio station or the information provider. In most cases an advertiser sponsors the report and pays the information provider for the spot. Also, non-consumers may benefit from other traveler's consumption of traffic information. Travelers who change their route after listening to a traffic broadcast of an accident can significantly reduce the travel times of those who did not listen or were not able to divert their routes. As a result, society receives benefits which are not reflected in the price consumers are willing to pay.

The objective of this study is to provide an overview of the commercial traffic information services in the U.S. and to develop an economic model of traffic information systems that incorporates the value of information to travelers and traffic managers, the technologies for collecting and disseminating information, and the competitive and cooperative arrangement among enterprises (private and public) that provide this information. The model aims to explain why firms providing traffic information are what

they are, and to determine what kinds of enterprise activities and arrangements would best meet traveler needs, including the role of public agencies that are concerned with system management.

1.2 Overview

The report is organized into six sections. The first part describes the motivation behind the research performed, the objectives of the project, and the approach taken by the authors. The second section provides an anecdotal perspective of the traffic information industry suggesting important factors that have affected the performance of the industry; an historical account of traffic report giving, including histories, and the beginnings of three of today's companies. In the third section, the participants (i.e., sponsors, radio stations, and information providers) involved in the industry are described, including the relationships between them and the incentives of each participant. The different methods of collecting information, the cost function faced by information suppliers, and the potential effects these factors have on competition are also examined. In the fourth section, a model is proposed that describes the demand for traffic reports among broadcast stations. Various products and services can be derived from the data retrieved from traffic information systems; companies repackage and resell the information to travelers. This market is discussed in the fifth section. In the final section, the question of whether the public should be involved in the industry as well as an outlook of the industry are examined.

1.3 Review of Literature

The behavior of travelers (e.g., choice of route or mode or departure time) influences the performance of a transportation network and impact the operations of ATIS. Thus it is important to know how ATIS will affect travelers' decisions. Extensive research has been conducted on the understanding of travelers' behavior and how their route choice might change if they were given some relevant pre-trip information. Previous research has

focused on the demand for an ATIS system. Beaton and Sadana (1995) developed and tested the market for a corridor-specific pre-trip ATIS system in New Jersey. Results indicate that there is a strong interest for an ATIS service and for information estimating the expected delay for an incident, but not for information regarding alternate routes. Their study also showed that commuters are willing to pay between $3 and $4 per month for basic ATIS services.

Research has also been performed to determine the factors which affect commuters' behavior and decision-making. Abdel-Aty et al. (1995) provided insight on how commuters obtained their information, how they used pre-trip and en route traffic information, and how willing they were to divert to another route given such information. They found that the commuter's perception of the accuracy of the report significantly influenced the decision to change routes. Khattak et al. (1996) used stated preference models to study how travelers might respond to future ATIS technologies and unexpected congestion. Respondents were willing to use an ATIS device which gave accurate delay information, usually either by changing their departure time or taking an alternate route; very few were willing to take public transportation (2%). The potential benefits of traffic information (e.g., travel-time savings and congestion delay reductions) and the effectiveness of ATIS to reduce delay caused by incidents has also been studied (Hall, 1993).

A previous working paper (Malchow, 1996) reviewed most of the other relevant literature regarding the economics of traffic information. Different methods that model traveler decision-making as well as plausible demand and supply models for traffic information were presented. In a second working paper (Malchow, 1997), different models were proposed to represent the behavior of information providers in their choice of location. The models showed that providers in a competitive environment would have a tendency to cluster, i.e., collect information about the same locations.

Other works have evaluated the quality of traffic information provided by specific information systems. Since the development and deployment of many ATIS systems involve public-private partnerships, the success of and lessons learned from these experiments have been documented. Daniels et al. (1976) analyzed the behavior and attitudes of drivers toward driving information in the Chicago area. They concluded that traffic reports would reach more travelers if the commercial traffic reports given were more accurate and timely. Also, more drivers could be reached if more radio stations provided traffic reports. However, literature investigating the structure of the traffic information industry and how the providers (both public and private) interact with the consumers, i.e., radio stations and travelers, is limited and restricted. Commercial information suppliers have conducted internal research in areas such as determining the "best" method of collecting information, but these results remain proprietary. Contract details between the information provider and its affiliates also remain proprietary information.

Many of the ideas presented in this discussion of the industry evolved from a variety of sources: phone interviews with several information providers, site visits to three traffic information providers and two radio stations in the San Francisco Bay Area, published articles and books, and a survey distributed to companies across the United States, Europe, and Japan. However, because the data available at the industry level are limited in scope and detail, news publications provided most of the information about how the industry operated, how it has changed in recent years, and who the major actors were in the industry. The collection of articles is not considered comprehensive by any means; the interviews conducted provided a more complete portrait of the industry's structure and the manner in which it operates.

2. HISTORY OF THE INDUSTRY

In order to explain the behavior of traffic information providing firms, it is necessary to first examine their past. The history of the traffic information industry is presented in the following chapter, providing not only a sense of how the industry got started and where it has been, but also some insight as to where the industry is headed. The first section describes what may be the first traffic report given in the country and the growth of traffic reporting which evolved from this. A chronicle of three of today's information services is provided next. The last section describes the start of some of the local traffic reporting services.

2.1 The First Report

Traffic reports have been around for forty years. Today they are a regular part of morning and afternoon radio programming and have come a long way since their debut. The start of traffic reporting is not well documented; the nation's first traffic report may have been delivered by chance in the Bay Area in 1957 (Durling, 1997; Castillo, 1986). Hap Harper was a neighbor of Don Sherwood, a popular disc jockey at that time for radio station KSFO-AM. Harper was a private pilot who flew every morning to give live weather reports for KSFO. During one of his live broadcasts, he noticed a stalled car on the upper deck of the Bay Bridge as he was flying and mentioned the stalled car on the air. He then commented that as a result, traffic was backed up to the toll plaza. The next day Harper was asked to fly over the Bay Bridge every day, to give reports on the traffic conditions.

News spread about KSFO's traffic reporters and in 1958, KMPC, KSFO's sister station in Los Angeles, began flying two aircraft. Other radio stations across the country began to see a demand among listeners for traffic reports and started to broadcast traffic information. The height of traffic reporting occurred around 1976. Historically, traffic reporters were private pilots who learned how to talk on the radio. Many broadcasters

learned to fly and gave up their jobs to start traffic reporting companies. At one time, there were "hundreds" of information providers, since each radio station employed their own reporter and bore the cost of their own aircraft. It should be noted that traffic reports were not as common as they are today; not every radio station provided them. Ultimately, due to the high costs of operating an aircraft, most of the companies could not afford to fly planes and went out of business.

2.2 The Growth of Traffic Reporting Services

As congestion on the roadways has worsened, the demand for up-to-the minute traffic reports has grown. Studies conducted by numerous stations have shown that traffic reporting is important to listeners. Radio stations provide the information to their listeners as a type of community service since many stations' primary focus is the music and not news or traffic reports. The provision of traffic reports is also seen as a means to attract more listeners, or at least not lose listeners, who are interested in road conditions. In one case, the broadcasting of traffic reports brought the radio station's ratings during the morning drive to the top (Hunt, 1985). Most stations do not have the money to operate their own aircraft and hire a traffic reporter and have come to rely on traffic reporting services to provide them with traffic reports.

The two largest private traffic reporting services in the country today are Metro Networks, based in Houston, and Shadow Broadcast Services, based in Philadelphia. These traffic information providers offer their services on a barter system; traffic reporting services supply the radio station with traffic reports in return for inventory, i.e., air time. The air time is subsequently sold to advertisers. Therefore, radio stations are not usually paying a fee for the service. A third provider, Smart Route Systems, has developed in recent years; their main media is telephony, but they also market their information to broadcast stations and cellular phone services. Here, the broadcast stations usually pay a fee rather than transfer inventory to the providers. Despite the

common perception that every station has its own helicopter and reporter, typically only one or two private information providers exist in a metropolitan area. The relationships between the various parties in the industry are explained in more detail in Chapter 3. Public agencies also provide traffic and transit information and have funded many ATIS projects, e.g., TravInfo in the Bay Area, but the focus of this section will be on the private sector.

2.2.1 Metro Networks

The need for better traffic reporting inspired the beginning of Metro Traffic, which started in 1978. The idea was to broadcast the locations of local traffic jams such that drivers would be able to avoid them. To do this, mobile units were placed on the roads to observe traffic conditions and report via two-way radio to a central studio with aerial spotting for back up purposes. The information was then assembled into professional reports by a broadcaster. Since its beginning, their basic operations have remained unchanged while expanding into more than 60 U.S. markets. The company's main source of revenue has been generated from the packaging and selling of the commercial airtime inventory provided by their radio and television affiliates.

Current reports show that Metro is the largest provider of traffic report services in the U.S., serving approximately 1,275 radio affiliates and 110 television affiliates. A list of their markets and the number of affiliates in each market is provided in the appendix. Although Figure 2.1, below, is only a rough approximation of the company's gain in new markets, it can be seen that Metro has grown dramatically during the last decade, more than tripling the number of markets from 20 in 1987 to 66 in 1997, and continues to grow. Since January 1994, they have entered 27 new markets and according to the company's prospectus, their annual revenue has increased in each of the last 18 years except in 1992 and 1995. The company went public in October 1996 and expects to expand into the remaining 18 of the 75 largest MSA markets through acquisitions and start-up operations

over the next three years. They envision opportunities for development in areas such as customized programming.

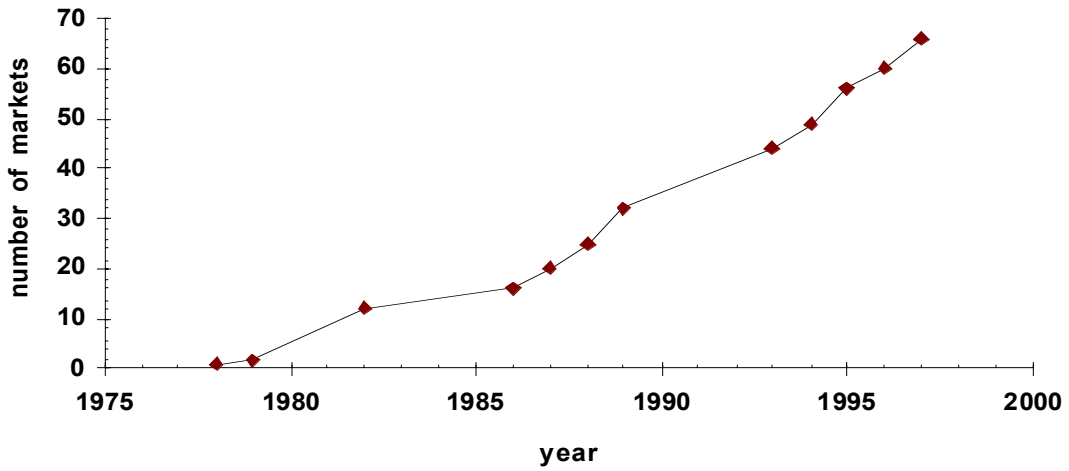

Figure 2.1: Metro Networks, 1978-1997

In addition to providing traffic reports, Metro Networks has expanded into other markets: local and regional news; weather and sports broadcasts; television traffic and; video news services. They have also become involved with traffic management systems (e.g. TravInfo in the San Francisco Bay Area) for local, state, and federal government agencies. Metro Networks is the parent company to Metro Traffic Control, Metro Networks News and Sports, Road Watch America, Metro WeatherBank, and a group of other enterprises.

Although Metro went abroad and began operations in the United Kingdom in 1992[1], their expansion efforts during the last couple of years have focused on acquiring other traffic reporting operations in smaller areas rather than starting up operations. In some cases, this meant eliminating the competition. By acquiring operations in new markets, Metro is able to experience some economies of scale. In addition, their advertisers are then able to purchase spots at the national level and have their sponsorships heard in more cities.

Other sources for the growth in revenue are the increased demand among broadcast stations for traffic reports in cities of all sizes.

2.2.2 Shadow Broadcast Services

Shadow Broadcast Services is Metro Network's largest competitor. Limited information is available about Shadow primarily because they are not a public company themselves but a subsidiary of Westwood One and affiliated with Westinghouse and Infinity Broadcasting. Shadow Traffic presently operates in fewer cities than Metro Traffic does and has undergone several re-organizations since it was launched in 1976. Thus, the history of Shadow provided here is only a partial one and should not be considered complete.

Shadow Broadcast Services was started by truckers and drivers exchanging traffic tips to each other via CB under the handle "Shadow." In 1992, Jim Battiagliese, a former employee of the Shadow Traffic Network in Philadelphia, organized Express Traffic under the ownership of New York-based Shadow Broadcast Services. Philadelphia's Shadow Traffic merged with its competition, ARCO Go Patrol and the Sunoco Traffic Update, in 1985. After undergoing few names and more changes, they went bankrupt in 1990. Today, Express Traffic has traffic operations in fifteen other cities and the service is called Shadow Traffic.

Although Shadow started operating before Metro, they have not experienced the same growth. However, with the backing of the well-financed Westwood and Infinity, they have recently established an aggressive strategic growth plan to reach 27 cities in 1997. Since 1990, when the company commenced, Shadow Traffic has entered 10 new markets, including four in the past year. They have also been able to invest in new equipment (e.g., 20 video cameras in New York) to help disclaim some of the operations' reputation as a "less-than-accurate source of information (Thompson, 1996)."

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[1] The U.K. operation went into liquidation after only two years and was reinstated in June 1995.

Similar to Metro, Shadow expanded its scope and began offering customized news, weather, and sports broadcasts to radio stations in 1992. These service are also provided on a barter basis. In the future, business and entertainment news may also be offered. Currently, Shadow provides traffic, news, sports, and weather programming to more than 400 radio and television stations nationwide and reaches about 40 million listeners.

2.2.3 SmartRoute Systems

Enroute Systems, founded in April 1988, started in response to an individual's need for more accurate and timely traffic information. The plan was to "develop a real-time, on-demand, location-specific transportation information system which would gather, consolidate, and disseminate traffic information to the travelers (DeBlasio, 1994)." Enroute started with a hardware approach by developing a prototype in-vehicle unit which would gather and disseminate traffic information via cellular. However, they soon changed their approach and focused on packaging and reselling information, using the telephone as their media to drivers. In 1991, Enroute Systems re-organized and became SmartRoute System, Inc. SmartRoute began its operations in Boston in May 1991 and launched its second site in Cincinnati in June 1995. They are presently expanding to New York, Philadelphia, Washington, D.C., and Minneapolis-St. Paul and have expressed a desire to expand to the forty largest U.S. cities.

Unlike Metro and Shadow, SmartRoute does not generate its revenue by selling advertising. Instead, they sell their information services directly to commercial vehicle operators, delivery services, radio stations, and individual cellular phone users. Thus, SmartRoute receives a monetary value for the information and is not compensated with inventory. Another source of revenue comes from cellular phone companies which pay SmartRoute to play customized messages at the beginning of a traffic report. In addition, SmartRoute has received public funding from both the Federal Highway Administration as a field-operations test and from the Massachusetts Highway Department for designing

and operating *SmarTraveler*, a telephony ATIS project in the Boston metropolitan area. *SmarTraveler* provides real-time route-specific traffic and transit information and can be accessed from any touch-tone phone or cellular phone free of charge[2]. The unique public/private relationship SmartRoute created with government agencies might be used as a model for future incident management projects. This is discussed in more detail in Chapter 6.

2.2.4 Local Information Providers

The success of traffic reporting services such as Metro Networks has spawned a number of local competitors. Because of the smaller, more independent nature of local providers, a complete list of all existing traffic information providers would be too difficult to assemble. This is also due to the fact that the industry has not been well documented and much information remains proprietary. Finally, as evidenced in a list of traffic reporting services provided in the appendix, many of the companies which once existed have been acquired by either Metro Networks or Shadow Traffic.

In some cities, traffic information providers were started by former Metro employees who felt that there was room for competition, as radio stations have expressed dissatisfaction with Metro's services (Welch, 1988; Levine, 1995). Since Metro is the dominant provider in most markets, they may not be overly concerned about catering to the individual affiliate's needs, which can lead to a decrease in Metro's quality. And some stations prefer having local people report the traffic and dislike dealing with the procedures and policies devised by the national people at Metro's headquarters (Welch, 1988).

Local providers try to differentiate themselves from the competition, usually either by doing custom feeds or by using aircraft to cover traffic conditions. Metro's competitors

[2] Due contracts negotiated with the various cellular providers, only calls placed within local boundaries are free.

tend to take on a more personal approach to traffic reporting. For example, Traffic Watch, Metro's rival in Baltimore, reported to specific radio or television stations at an assigned time, while Metro's network reports were aired by all the stations during the same time period (Synder, 1988). It should be noted that Metro currently customizes their reports to the individual radio and television stations.

In some markets however, radio stations that choose to collect their own traffic information are the only competition for national providers such as Metro. Some radio stations feel it is more efficient to lease their own aircraft and/or mobile units and hire their own traffic reporters than to contract with a traffic information service. Thus, these radio stations do not give up any commercial inventory and are able to directly sell the air time around the traffic report to advertisers. By being able to collect their own traffic information, radio stations not only have more control over the type and format of the information disseminated but they can also serve as a check point for its competitors if the market was not competitive.

2.3 Different Services Offered

It can be seen from the above descriptions of the various companies that different types of traffic information exist. In some instances, the market was created as a result of a new service; other times, the demands and needs of the consumers created different services. A company will often try to capture market share by producing a product which is different from its competitor. However, for traffic information, the differences between the services offered are sometimes subtle. This may be due to the similar sources of information used by the different providers. For example, the most common methods of collecting information include use of multi-channeled police and emergency scanners, the highway patrol's computer assisted dispatch (CAD), and aircraft. Since all providers receive the same information from the public data sources, the contents of traffic reports given by competing companies often do not differ by much. The largest differences

appear in the style in which each provider chooses to report rather than the content of each report. Although the amount of information available is vast, each report is restricted to 60-90 seconds in length. As a result, all providers will choose to report on incidents which affect the greatest number of travelers.

Technological advances in recent years have contributed to the growth of service differentiation in the traffic reporting industry. Traffic information can be disseminated to the traffic information provider's affiliates and customers in several ways. The reports heard over radio stations are usually given by a broadcaster from the traffic information provider's studio through equalized phone lines, which allow the broadcaster to be in his studio and sound as if he were at the radio station. Some stations receive traffic reports which are given by air borne reporters while other stations have their own broadcasters report from faxes provided by the traffic reporting service. Travelers today are also able to view the traffic conditions on the Internet. Websites are set up in most major cities which show the speeds along certain sections of the roadways as well as report on incidents or accidents on the network. The difference between the information available on the Internet and that on a radio is that more information can be given on a website, because commercial traffic reports are limited in time. Additional details about traffic incidents, as well as information about other incidents can be delivered via the Internet.

In recent years, travelers have also become able to receive traffic information via faxing or paging services. In such cases, a report is faxed to the customer within minutes of his request. Other than a fax machine, no special equipment is not required for this service. There are two approaches to the paging of information. Some companies have attempted to market their own paging device which is connected to the traffic information service. In order to receive traffic information, individuals would purchase the gadget and pay a monthly service fee. This approach has not been very successful because it requires the traveler, who can obtain free information from the radio, to make an investment. The other approach utilizes the alphanumeric pager already available on the market. The

pager is programmed to receive and display traffic information, including accident reports, scheduled road/ramp closures, and roadway conditions. The different economies describing these products will be addressed later.

As a result of the different types of services offered, different levels of service have been introduced into the market. For example, the information broadcast over the radio is limited in scope while the information available on the Internet is more comprehensive. The paging services allow the customer to choose the routes and areas he wants covered in his reports as well as the information received, i.e., reports which only provide information about areas where traffic is moving below a certain speed or reports which only provide information regarding incidents affecting normal traffic flow on freeways, ramps, or major surface streets.

In the future, a more elaborate tiered market for traffic information may develop in which products of different levels of quality are offered at varying prices for different customers. Before such developments, traffic information was only available in certain forms, i.e., commercial radio broadcasts. Although traffic reporting has proven to be a profitable venture, many of the local providers have not been able to endure the competition from Metro. The trend toward a monopolistic industry and the factors which promote this type of behavior and development are addressed in the next chapters.

3. STRUCTURE OF THE INDUSTRY

In this section, the operations and motivations of the actors in the industry are explored. First, the overall flow of information is briefly described. Then, the role of traffic information providers and the broadcast stations for whom they supply the information to are examined.

3.1 Flow of Information

The economic network of the industry varies from market to market, but the most common scenario is as follows:

- The information providers (e.g., Metro Traffic, Shadow Broadcast Services) collect the information. This information can be collected in a number of ways.
- The information providers then market their information to broadcast stations. The broadcast stations give the traffic information provider a fixed amount of airtime (which has an opportunity cost to the station). The information providers then agree to fill most of this allotment with traffic information and sell the remaining segment to an advertising sponsor.

In most cases there is also a transfer of money between the information providers and the broadcast stations. The direction of this transfer may vary with the presence of competition among information providers, and the magnitude varies with the size of the demand for information. This issue is further explored in Section 4 where a new model for the demand for traffic information is proposed.

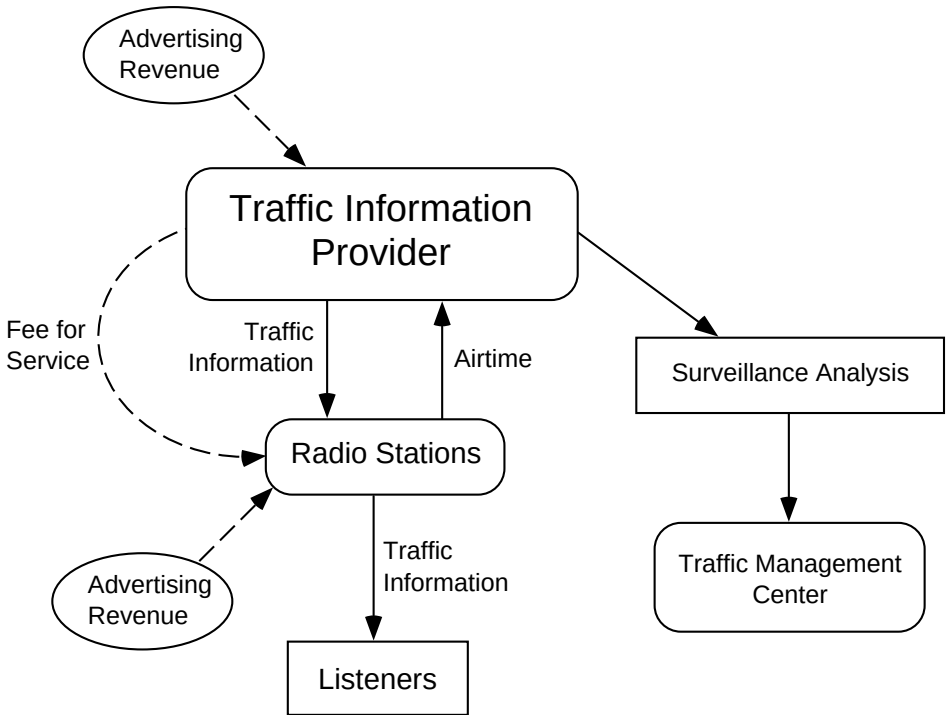

Figure 3.1: Flow of Information

3.2 Traffic Information Providers

3.2.1 Methods of Collecting Information

The primary methods used by information providers to collect the traffic information appear to vary tremendously from one city to the next, including:

- monitoring of highway patrol computer-aided dispatch (CAD)
- surveillance aircraft
- cellular phone probe vehicles
- closed-circuit television
- automatic vehicle identification (AVI) probe vehicles
- loop detector data

Of these, CAD is the only method used in all metropolitan areas. Perhaps this is because of its low operating cost, its wide availability, and its listing of real-time incidents. In most cities, providers appear to use methods which are presently operated by the city and then only add their own gathering if necessary. The choice amongst the available data collection methods seems to be driven by the questions outlined in Figure 3.2 below.

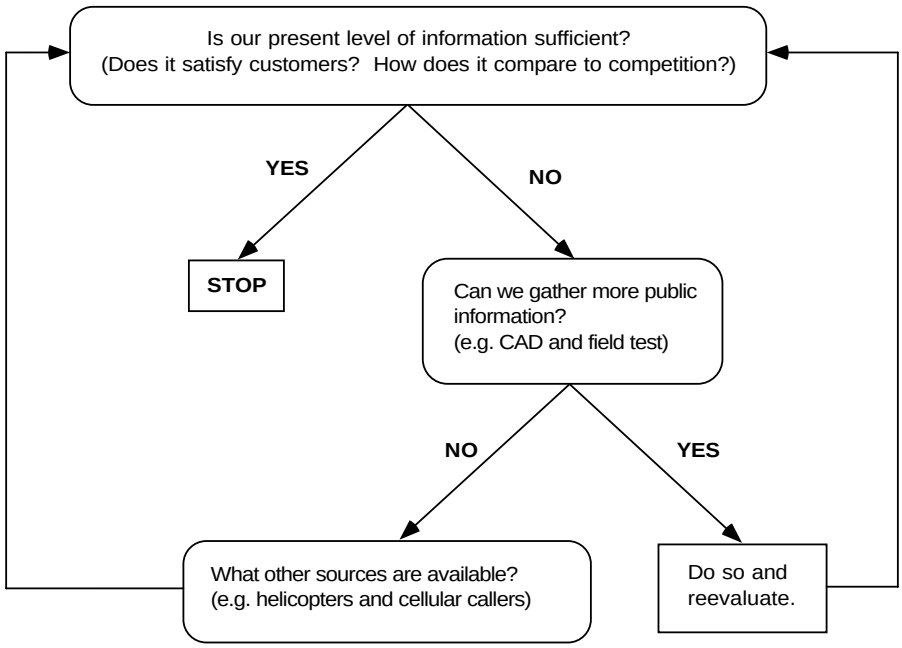

Figure 3.2: Choice of Data Collection Method Decision Tree

- *Does the information presently collected provide sufficient reports?* The various providers handle these questions in different ways. According to the results of our survey, this appears to depend upon the presence of competing information providers, the competition's level of accuracy, and the ability of broadcast stations to differentiate among products. This would, of course, be motivated by their desire to maintain customers.
- *If the information collected is insufficient, what source should be used next?* Each method has its own marginal benefits, limitations, and costs.

3.2.1.1 Aircraft

Helicopters and planes are often visible ways that providers can show that they are monitoring traffic. Despite the costs ($60/hr for aircraft and $400/hr for helicopter) and its difficulty in bad weather, many providers use aircraft to remain competitive.

3.2.1.2 Cellular Phones

Different information providers have negotiated contracts with cellular phone companies to encourage their use for traffic information purposes. For example, a user of GTE Cellular might be offered 100 free minutes per month if he reports to the provider as a member of the phone force. Similarly, awards can be given to the call-of-the-month or the tip-of-the-day. In addition to these monetary incentives, many callers will report an incident just for the chance to hear their name over the radio (Burford, 1997). For instance, in the Bay Area, the two primary radio stations for traffic information are KCBS-AM and KGO-AM. Each company has an exclusive contract with one cellular provider, either Cellular One or GTE Cellular. Drivers who subscribe to Cellular One can call KCBS free-of-charge to report an incident. Similarly, drivers who subscribe to GTE Cellular can call KGO free-of-charge. For part of the day, the radio station receives the call themselves, while at other times the calls are forwarded to either Shadow Broadcast Services or Metro Traffic. These promotional agreements allow the information collectors to gather information at minimal cost while the cellular providers receive free mention of their services on the radio. Another example is Smart Route Systems which has negotiated contracts with cellular providers such that callers may call to receive free traffic updates. In return, cellular providers are allowed to preface each traffic report with a promotional message. However, despite the advantages of using cellular phone connections to obtain traffic information, the accuracy of these reports is questionable.

3.3 Traffic Information Consumers

Traffic information providers generally supply their traffic information to radio and television stations on a barter basis. Due to the high costs of aircraft rental and maintaining a traffic reporting staff, most radio stations choose to forfeit commercial slots to traffic information providers in exchange for traffic reports. Radio stations provide traffic reports to attract listeners and count on traffic reports almost as much as popular on-air personalities. In effect, the larger listener base they have, the higher the advertising

rate they can charge. Similarly, if the information provider is able to sign-up radio stations with major market shares, they too can raise the sponsorship rate.

Other consumers of traffic information include traffic reporting services which repackage the information and government agencies. Traffic information is available via the Internet for some cities (e.g., Los Angeles, http://www.scubed.com/caltrans/transnet.htm; Chicago, http://www.ai.eecs.uic.edu/GCM/CongestionMAP.html). The majority of these appear to be financed by public agencies. For example, the Los Angeles map is sponsored in part by Caltrans while the Chicago's site is sponsored by the Illinois' and Indiana's DOTs. Government agencies have also sponsored projects using the telephone as the media (e.g., SmartRoutes in the Boston area).

3.4 Trends

In recent years, the market for traffic information has migrated toward a monopolistic state. This trend is a result of the economies of scope and scale inherent in the market, as well as some characteristics of larger agencies. Economies of scope result when larger agencies buy out local information providers. The buyer which already has operations in the area, does not absorb many additional costs and inherits a profitable list of new customers. The additional costs are small since the provider experiences decreasing average costs. This is due to the decreasing impact of fixed costs (i.e., broadcast equipment) and linear variable costs (i.e., personnel). Economies of scale result from larger agencies having the resources and captial to provide more information than their smaller competitors (i.e., more accurate reports). This makes them more competitive and attractive as an information source. Large agencies such as Metro and Shadow have two characteristics which give them a greater advantage over small, local providers: (a) they have a larger financial base (Metro recently went public in 10/96, and Shadow is a subsidiary of the much-larger Westwood One), and (b) the promise to broadcast stations of increased advertisement from national sponsors which the national providers can offer through its nationwide connections.

4. DEMAND MODEL FOR TRAFFIC INFORMATION

One of the most unique characteristics of the traffic information economy is the shape of the demand function for traffic reports which characterizes broadcast stations.

For the commercial station, it is assumed that the cost of airing a traffic information spot is the same as running a regular program. In addition, all other programming decisions are assumed to remain fixed, e.g., number of songs, weather reports, etc. Thus, the objective of the station managers would be to maximize the revenue, which in turn maximizes their profits. The revenue of a station can be given as :

$$R = f\left(g(T)\right) ? h(T)$$

where R = revenue of the station
T = number of traffic reports given
$g(T)$ = number of listeners as a function of traffic spots
$f\left(g(T)\right)$ = advertising rate as a function of listeners
$h(T)$ = number of spots still to be sold to advertisers

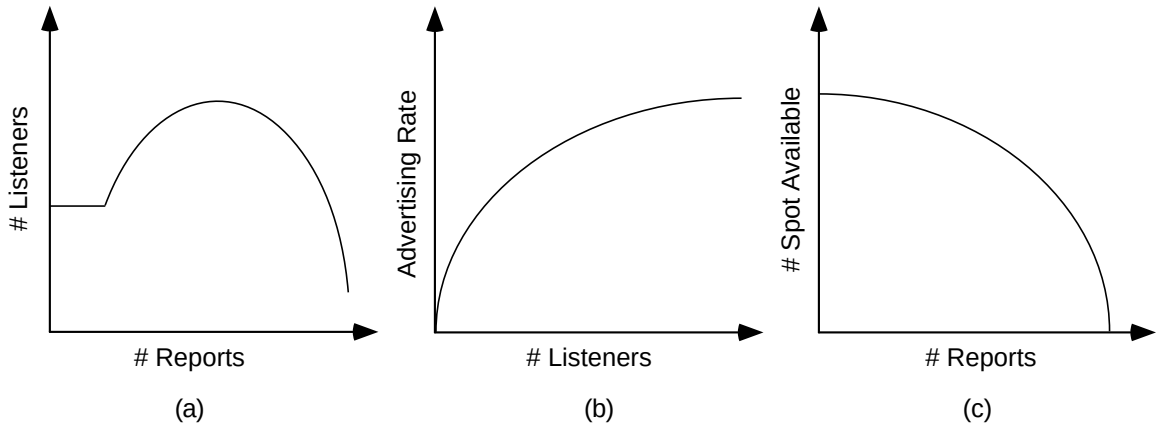

Figure 4.1: Relationships Used to Derive the Demand Model

The first function, g(T), would be of a shape similar to Figure 4.1a, above. As shown, the initial reports have little impact, because the traffic reports would be spaced too far apart to affect listener's decisions. As the number of reports increases (i.e., the reports become

more frequent), the size of the audience would also gradually increase, until it reaches a maximum level, after which listeners would begin to turn away because traffic reports become too frequent. The second function, $f(g(T))$, is shown in Figure 4.1b, and would be a function which increases monotonically with T, but at a decreasing rate; that is, $\frac{f(f(g(T)))}{fT} > 0$ and $\frac{f^2 f(g(T))}{fT^2} < 0$. The third function, h(t), shown in Figure 4.1c above, would likely be a decreasing function, with its rate of change increasing as the number of reports increased. This relationship would result because broadcast stations would initially use traffic reports to replace programming, but would gradually be forced to use them in place of commercial spots. Mathematically, $\frac{fh(T)}{f\ T} < 0$ and $\frac{f^2 h(T)}{fT^2} > 0$.

The objective of the information providers, to maximize profits, can be formalized as:

$\pi = W(T) - C(T)$ where π = provider's profits
T = number of reports given
W = station's total willingness-to-pay
C = provider's total cost

It can be shown from this equation that:

$\frac{f\pi}{fT} = \frac{f(W)}{fT} - \frac{f(C)}{ft} = 0$ if the provider is maximizing profits.

Thus $\frac{f(W)}{fT} = \frac{f(C)}{fT}$, or the market price is equal to the marginal cost.

For the commercial station, it is known that:

$\frac{fR}{fT} = \frac{ff}{fg(T)} ? \frac{fg(T)}{fT} ? h(T) + f(g(T)) ? \frac{fh(T)}{fT} = 0$ if the radio station is maximizing its profits. This case is represented by point T_1 on proposed demand model for traffic information shown in Figure 4.2.

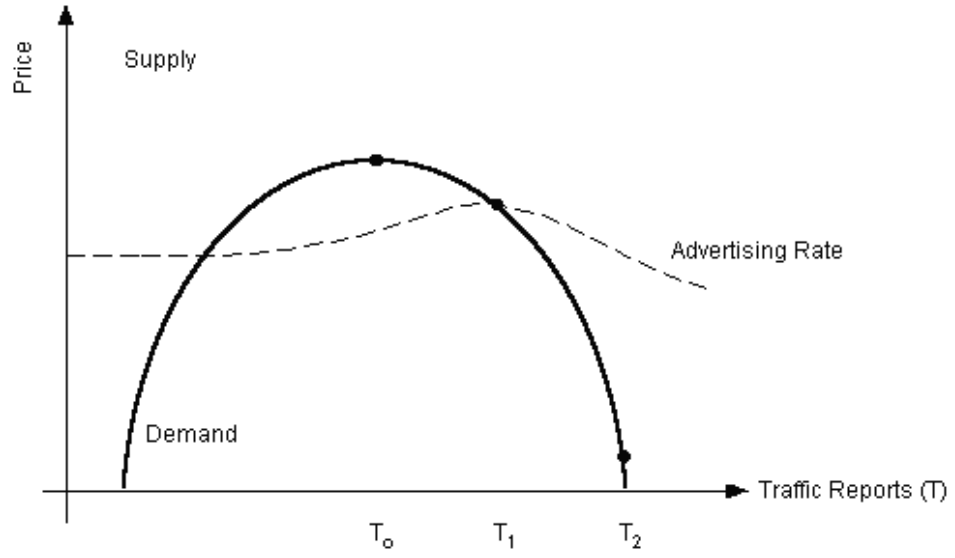

Figure 4.2: Supply and Demand Model for Traffic Information

After the value T_1, at which $\frac{\partial r(T_1)}{\partial T} = 0$, the radio stations themselves will not willingly trade for traffic information, since they will not gain revenue. Although radio stations exhibit a willingness-to-pay, this amount is less than the opportunity cost of the time necessary for a report. However, the information providers are not yet maximizing profits, i.e., $\frac{\partial \pi}{\partial T} > 0$. As a result, the information providers should choose to pay the radio station an amount $-\frac{\partial R}{\partial T}$ to allow them to give another traffic report. In effect, the information provider would buy airtime since they can resell it to a sponsor for a higher price.

As T increases, the radio stations would lose more money and R would further decrease. Thus we can hypothesize that $\frac{\partial^2 R}{\partial T^2} << 0$, and the amount of money which the information provider would need to compensate the radio station would continue to increase with T. Information providers would continue to pay radio stations as long as the revenue derived from one additional report exceeds their cost (i.e., the combination of

their operations and the payment to the radio station). This continues until the provider's marginal profit falls to zero, at which

$$\frac{f\pi}{fT} = S(T) - \frac{fC}{fT} - \frac{fR}{fT} = 0 \ ,$$

where S(T) is the (decreasing) sponsorship rate as a function of the number of reports.

Observations made from this arrangement related to: (a) the differences in the number of reports ideally consumed under competitive and monopolistic environments; (b) changes in the direction of monetary transfers under competitive and monopolistic environments; and (c) the differences between the competitive equilibrium and where participants presently choose to position themselves, as well as the assumptions which could be made about the quality of the information gathered under different environments.

With regard to the first and second observation, recall how the broadcast stations' willingness-to-pay for information under competitive equilibrium would fall below the value of necessary airtime. As a result, information providers in a competitive market would ideally buy airtime at a fraction of the cost commercial advertisers paid. As the amount of compensation received by the radio stations increases (i.e., as their demand curve falls), the market approaches competitive equilibrium at T_2. In the case of a monopolistic environment, in which one firm would be profit maximizing, the point-of-stability would be somewhere between T_0 and T_2. Thus, the single provider would raise the market price and lessen the number of reports which could be sold. It is possible that the information provider would limit sales to an amount less than T_1 such that the broadcast station pays the information provider a monetary sum in addition to allocating the airtime. In either case, the number of traffic reports available to drivers would be less, and broadcast stations would bear a larger share of the cost. This is similar to most other monopolies, where the level of production is limited and the market price is raised.

With regard to the second and third observations, it is clear that a gap exists between the maximum price which broadcast stations are willing-to-pay for a traffic report and the minimum price at which information providers can produce a report. This situation arises particularly at the level of traffic reports consumed at T_1. This is believed to be the current situation because information providers are not believed to be bartering with radio stations to increase the number of traffic reports. The information provider's immediate objective is to contract a station and allow the station to decide the program format. It should be noted at this point that, the information providers can make a sizable profit from the contracting of a broadcast station. The profit potential is high in the industry, allowing providers to offer some broadcasters "generous compensation packages" (Borden, 1992). Providers are willing-to-pay up to the amount of this profit to ensure that the station does contract with the competition instead. As a result, under competitive scenarios, the information providers will pay the broadcast stations to allow them to provide their traffic information. Under monopolistic environments, the amount paid to broadcast stations would be held back, increasing the provider's profit. The important point this raises is that it would be in the economic interests of the broadcast stations, in particular, to ensure that competition is present within the market for traffic information.

Another inference can be made about the effects of competition on the quality of the traffic information. Clearly, as the quality of traffic information increases, the costs necessary to gather it must increase as well. With a higher average cost, an information provider would have a smaller profit margin (assuming the sponsorship rates remain unchanged), and thus would not be able to compensate a contracted station by as much as they previously could. Therefore, the broadcast station would be forced to decide between more money or a higher quality of information. The issue raises the question of how aware station listeners are of the accuracy of traffic information provided by various stations. That is, if the station subscribes to a information provider which supplies

reports of higher quality (i.e., more accurate), would the number of listeners (and thus the commercial rate) increase to compensate them for the money they rejected from the other provider. From observation, listeners are generally unaware of the differences. Program managers also expressed that stations of certain formats (e.g., music) would be less concerned with the quality than stations with program formats that emphasize the news. Thus, certain stations would choose the provider offering more money and lower quality, yet still providing adequate traffic information. However, a minimum standard should be set for the quality of information such that the station's listeners feel confident using it.

A similar situation arises in a monopolistic environment in which a station might decide between contracting out for traffic information or collecting and providing its own reports. There would likely exist some level of accuracy; below this level, the station would choose to collect information for itself rather than contract out. This is a very important issue regarding the future benefits to be expected from traffic information, and is expected to be addressed in future studies.

5. PROSPECTS FOR THE INDUSTRY

In addition to the commercial reports, various products and services can be derived from the data retrieved from traffic information systems. Value-Added-Resellers (VARs) are companies which repackage and resell the information to travelers. The following section describes some of the commercial products and services which VARs involved with the TravInfo project have considered developing as well as products and services available on the market today. These products will be used to develop a picture of the market which might emerge for VARs and the differences which exist between this market and for commercial broadcasts.

5.1 Value-Added-Resellers

The Traveler Information Center (TIC), TravInfo's nerve center, collects and integrates static and dynamic traveler information from a variety of sources, including loop detectors, closed circuit television, public transportation systems, signal and ramp metering, and emergency response units. TravInfo is organized as a public/private partnership: customized traffic and transit information are available to the public via touch-tone telephones and to formally registered VARs. These VARs have direct access to the database free of charge (during the test period) allowing them to "redistribute, enhance, repackage, or otherwise add value" to the data provided. The companies can then present the information in a more convenient and innovative form to their customers. Potential commercial products include pagers, cellular phones, automated route guidance, and kiosks.

As of July 1995, twenty companies had signed an agreement with TravInfo to become registered VARs (Loukakos et al, 1996). Interviews with VAR managers at each company were conducted to evaluate how the information derived from the TIC will be used. Prior to their participation as VARs, many of the companies were already developing and marketing dynamic and multi-modal ATIS products. For example, Metro Traffic, in addition to providing traffic reports to many of the radio stations in the Bay

Area, also provides customized real-time travel information to a number of corporations. Navigation Technologies (NavTech) provides navigable digital databases which are used for in-vehicle route guidance, fleet management, and personal navigation systems. In general, the VARs took three approaches: (a) customized, route-specific information; (b) routing and alternate route information; and (c) in-vehicle navigation and route guidance.

Since the VARs are currently involved in the market, they intend to use the information to expand on and/or enhance their current products/services by being able to update their information more frequently. These products/services include: traffic and transit conditions, road construction, incidents, ride-matching, commuting alternatives, and routing. In addition, eighty percent of the VARs intend to introduce a new ATIS product/service by the end of 1997.

Many of the planned products and services require some type of communication equipment. For example, Clarion, a manufacturer of car audio equipment and other mobile electronic products, hopes to introduce the NAX9100, an in-vehicle navigation system. The NAX9100 is CD-ROM-based and designed to pick up and decode real-time traffic information data from wireless broadcasts. The system alerts drivers by displaying the area affected by traffic congestion, construction, or incident on their screen. Another feature the system offers is finding the best route between given origin and destination points. However, users must purchase the equipment which includes an antenna, the video monitor, and Gyro sensor before being able to receive in-vehicle information. Clarion plans to sell the NAX9100 for approximately $2000 to its customers.

Another company has developed an on-line transportation demand management/rideshare system. The system will directly disseminate the information to its end-users. Users of the on-line system connect via both networks and modem dial-ups to access information about commute alternatives as well as coordinate ridesharing efforts. A similar system

will also be offered by a private, non-profit organization to individuals, catering to their needs and can be accessed by telephone, fax, and mail. Costs for these services were not available.

As described in Chapter 2, services will also be provided by companies such as SmartRoutes. Travelers can receive updated traffic or transit information via voice-mail, e-mail, paging services, and faxing services. Customized, route-specific traffic information can be processed and then distributed to individuals via fax, e-mail, or page within minutes of obtaining the information..

5.2 The Market for VARs

Although VARs also provide traffic and transit information to travelers just as information providers such as Metro Traffic and Shadow Broadcast do, VARs differ in that their revenue is often derived directly from their customers. Travelers who subscribe to these services pay a fee, usually monthly, for the information they receive. The direct payment creates a more classic demand market. For example, companies can create more specialized products to develop the tiered market which is common for other goods, and they can charge prices which differ for each specialized product. Many studies have found that the largest market for specialized products exists with commercial vehicles (e.g., distributors, taxicabs, rental agencies). These individuals are willing to pay for tools such as route guidance, because they are often traveling in unfamiliar areas.

Many attempts have been made to sell customized traffic information directly to the users. However, experience seems to show that individuals' willingness-to-pay is not very high and that the market for value-added information would be small. Beaton and Sadana's study showed that 7 percent of the respondents indicated they would subscribe to "basic ATIS services" with no monthly fee. This percentage drops to only 3.7 percent if a $5 fee is imposed for the same services (Beaton et al, 1995). Apparently, the public is not inclined to pay large subscription fees for traffic information and few people are

interested in obtaining traffic information from sources other than commercial radio broadcasts.

Also, most of the major cities in America have Web sites which offer real-time traveler information and live video images of the roads. Such information is available with low or no perceived cost to the user. As a result, companies that required their customers to purchase special equipment to receive the same information have not been able to sustain themselves. For example, in 1992 Way to Go developed a pager which would alert the individual of traffic jams and congested segments of the road. In order to receive the information, users needed to purchase the special pager for $199 as well as pay $15 in monthly service fees. The market did not respond well to the paging service since commercial traffic reports are readily available on the radio and Way to Go went out of business in 1993. Perhaps this is one of the signs that although a market exists for VAR services, it is not large enough to become profitable.

It is difficult to assess the true value of traffic information and evaluate the prospects for value-added products/services. Substantial amounts of funding have been invested, both by the public and the private sector, into developing and conducting market research for ATIS products and services. However, the individual VARs' research results are considered proprietary and unavailable. Surveys have also been conducted which examine the willingness-to-pay of travelers for traffic and transit information. Companies which have attempted to sell customized traffic information directly to travelers have not been very successful. The demand for traffic information services has not materialized, forcing some companies to go out of business. SmartRoutes, although still in operation, receives a significant portion of their funding from government sources and private companies. A similar example can be made of Metro Traffic's involvement with TravInfo. As of December 1996, the number of calls received by TravInfo was less than 100 per day. It is unlikely the potential advertising revenues would be able to cover the enormous cost of TravInfo's operations (greater than $6 million) and make it a profitable venture.

6. CONCLUSIONS

The specific conclusions from this study are:

- the industry is able to sustain itself;
- the industry is heading towards a monopolistic state; and
- the market for value-added information is small.

The market for traffic information appears to be technology driven in that the use of personalized information may increase significantly as technology advances. It is difficult, however, to determine how much individual commuters are willing to pay for this information. Studies (Perez, 1993) have shown that individual drivers can appreciate in-vehicle information devices, but do not value the information enough to pay more than the cost of the device itself. In addition, although potential VARs have expressed interest in the market, not much progress has been made to date. The one market in which navigation devices might be of interest is that of commercial operators since their value of travel time is higher than regular commuters; with the device they can better monitor their fleet. However, it remains unclear whether the demand is sufficient to support the market.

The uniqueness of the traffic information industry and the recent direction it has taken raises a very important issue. Since the industry is largely unregulated, and direct pricing is rarely employed between suppliers and users, many information operations are (at least partially) publicly financed as field operation tests or as new avenues of dissemination. The need for public financing is questionable since the costs could be mitigated by investments by competing private suppliers. Therefore, it is necessary to question what role the public agencies are best suited to play.

One potential role for public agencies would be the oversight of competition. Since the lack of it would result in a decrease in the number of traffic reports, an increase in the cost of those reports, and decrease in the quality of the information provided. Therefore, it

would appear to be in the best interests of both the public agencies (for financing of information projects, more accurate information for citizens) and the broadcast stations (lower fees, more accurate information for their listeners) to ensure that competition exists within local markets.

As previously mentioned, information providers appear to use the technologies of public investment first before they choose to use their own sources. This relationship might in some cases be reversed, to minimize the public's costs. (The results of the TravInfo collaboration may provide evidence for this.) If competition exists between information providers, they might see the financial incentive to improve their surveillance operations without public investment. Public operations, such as the freeway maintenance or incident removal, could then "piggyback" by monitoring the reports from the providers or establishing a connection to the provider' data (perhaps in return for the providers' connection to the police CAD). With access to providers' information, the need for further investment would fall, i.e. the marginal benefits would decrease while the marginal costs would remain unchanged.

6.1 Future Research

If a comparative study were conducted on the costs and benefits of having multiple providers, one could also examine the space available within metropolitan areas for competition. For example, is the number of potential customers (i.e. broadcast stations) large enough to support two competing information providers (and the fixed costs of surveillance necessary for each)? How difficult is the market to enter, due to the large fixed costs and the time necessary to develop contracts with broadcast stations?

In summary, the market for traffic information appears to be expanding rapidly in all dimensions, from the use of technology toward reduced costs, to the increased demand among information media and drivers, to the increased cooperation between public and private agencies. The growth in the demand for commercial broadcasts is evidenced by

the attention given them in stations' self-advertising. The potential for growth in personalized information exists, and numerous attempts are being made to capture this. The final shape in which the market will result will be driven by individuals' willingness to participate, and growth will stabilize only when the demand for information can grow no further or the technologies have reached their limitations.

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APPENDICES

Appendix A: LOCATIONS OF METRO TRAFFIC AND SHADOW BROADCAST

Metropolitan Statistical Area[3]	Metro Traffic	# of Radio Stations Served	Shadow Broadcast	# of Radio Stations Served
New York, NY	◆	28	◆	60
Los Angeles, CA	◆	55	◆	+
Chicago, IL	◆	33	◆	55
San Francisco/Oakland, CA	◆	28	◆	30
Philadelphia, PA	◆	35	◆	+
Detroit, MI	◆	26	◆	4
Dallas/Ft. Worth, TX	◆	30	◆	7
Washington, DC	◆	34	◆	22
Houston/Galveston, TX	◆	35	◆	23
Boston, MA	◆	32	◆	6
Miami/Ft. Lauderdale/Hollywood, FL	◆	32	◆	+
Atlanta, GA	◆	41		
Seattle/Tacoma, WA	◆	24		
Nassau/Suffolk, NY	◆	3		
San Diego, CA	◆	21	◆	+
Minneapolis/St. Paul, MN	◆	30		
St. Louis, MO	◆	27		
Baltimore, MD	◆	23	◆	+
Pittsburgh, PA	◆	25		
Phoenix, AZ	◆	38		
Tampa/St. Petersburg/Clearwater, FL	◆	30		
Cleveland, OH	◆	25		
Denver/Boulder, CO	◆	37		
Portland, OR	◆	21		
Cincinnati, OH	◆	2		
Kansas City, MO	◆	20		
Milwaukee/Racine, WI	◆	23		
Sacramento, CA	◆	38	◆	4
San Jose, CA	◆	9		
Providence/Warwick/Pawtucket, RI	◆	24		
Columbus, OH	◆	13		
Norfolk/Virginia Beach/Newport News, VA	◆	29		
San Antonio, TX	◆	24		

Note: ◆ = city traffic information provider serves
+ = data not available

[3] MSAs are listed in decreasing MSA population estimates for 1995-96.

Metropolitan Statistical Area	Metro Traffic	# of Radio Stations Served	Shadow Broadcast	# of Radio Stations Served
Salt Lake City/Ogden/Provo, UT	◆	24		
Indianapolis, IN	◆	19		
Charlotte/Gastonia/Rock Hill, NC	◆	21		
Orlando, FL	◆	27		
Buffalo/Niagara Falls, NY	◆	15		
Hartford, CT	◆	40		
Memphis, TN	◆	12		
Nashville, TN	◆	25		
Rochester, NY	◆	15		
West Palm Beach/Boca Raton, FL	◆	20		
Las Vegas, NV	◆	23		
Louisville, KY	◆	24		
Oklahoma City, OK	◆	8		
Jacksonville, FL	◆	21		
Austin, TX	◆	18		
Richmond, VA	◆	22		
Tucson, AZ	◆	12		
Albuquerque, NM	◆	12		
Wilmington, DE	◆	2		
Daytona Beach, FL	◆	5		

Note: ◆ = city traffic information provider serves
+ = data not available

Appendix B: LIST OF TRAFFIC INFORMATION PROVIDERS

Company Name	City	Year Started	Company Sold To	Year Sold
Aeromedia, Inc.	Salt Lake City	*	Metro Traffic	1/96
Air Traffic Communications	Santa Ana, CA	1989		
Air Watch Communications	San Diego, CA	1983		
Airborne Broadcast Consultants	Las Vegas, NV	*	Metro Traffic	3/95
Airborne Broadcast Systems, Inc.	Nashville and Memphis, TN Louisville, KY	*	Metro Traffic	3/95
Airborne Traffic Network, Inc.	Kansas City, KS Missouri and Omaha, Nebraska	1988	Metro Traffic	11/96
Baron Aviation, Inc.	Cleveland, OH	1985		
Charlotte Traffic Patrol, Inc.	Charlotte, NC	*	Metro Traffic	10/94
Computraffic	St. Louis, MI	*	Metro Traffic	1994
Florida Traffic Watch	Miami, FL	1995		
Hildebrand Communication, Inc.	St. Louis, MI	*	Metro Traffic	7/94
L.A. Network	Los Angeles, CA	1982		
Metro Networks	Baltimore	1978		
Road Watch	Connecticut	1993		
Shadow Broadcast Services	Philadelphia	1976		
Skyview Broadcasting Networks, Inc.	Phoenix and Tucson, AZ	*	Metro Traffic	7/94
SmarTraveler	Boston, MA Cincinnati, OH	*		
Traffic Central	San Francisco, CA	1986		
Traffic Net Group	Rhode Island and Connecticut	*	Metro Traffic	1/96
Traffic Patrol Broadcasting	Charlotte, NC	1986		
Traffic Patrol Broadcasting	Dallas, TX and Miami, FL	1984		
Traffic Patrol Broadcasting	Raleigh-Durham	1987		
Traffic Scan, Inc.	Atlanta, GA	*	Metro Traffic	3/95
Traffic Watch	Cincinnati and Columbus, OH Orlando, FL	1986	Metro Traffic	7/94
Traffic Watch	Baltimore	1983	Metro Traffic	7/94
Wisconsin Information Systems, Inc.	Oklahoma City, Albuquerque, Omaha	*	Metro Traffic	7/94