U.S. Department
of Transportation
Federal Highway
Administration

# TELECOMMUNICATIONS IN TRANSPORTATION

## A SUMMARY OF KEY ISSUES

**FEBRUARY, 1997**

Intelligent Transportation Systems
Joint Program Office

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## Background

Over the past several years, many states and local communities have been dealing with the need to substantially increase their usage of telecommunications for transportation. This is a result of the need to obtain more information on the status of traffic on the roadways, including video, to enable a response to those conditions. In addition, more and more data gathered from the transportation network will be made available to the traveling public in one form or another. Thus, the deployment of these and other Intelligent Transportation System (ITS) technologies, has required the development of sophisticated telecommunications networks to gather and distribute the data.

While the needs have been growing, the telecommunications industry has also been undergoing major changes in both technology and the marketplace. The Telecommunications Act of 1996 (TCA) has added new impetus to the change process. The days of a single telecommunications provider serving an area based on specific tariffs have disappeared, and have been replaced by a variety of companies that can serve the needs of the community, including public agencies, in a competitive environment. Further, because of this new competitive market, service providers are offering new levels of service at ever more attractive prices. In other words, the whole telecommunications business has changed dramatically. These changes can produce a major opportunity for public agencies that coincidentally are seeking to expand their telecommunications capability.

Other changes in the regulatory environment have been occurring in the same time frame. Several years ago, FHWA changed its policy on the use of Right Of Way (ROW) for utilities, and now AASHTO is in the process of altering its ROW policy. (The new AASHTO "*Guidance on Sharing Freeway and Highway Rights-of-Way for Telecommunications*" is attached as Reference 6.) Public-private partnerships are encouraged by the U.S. DOT, and Federal aid can now be utilized for operating expenses, including capital leases, as indicated in the FHWA Policy guidance of Reference 7; " *Policy Guidance on Section 301 of the National Highway System Designation Act of 1996".*

All of these changes have also created new challenges as government agencies have tried to work in this new environment. It is the purpose of this ***Telecommunications Resource Guide*** to provide an overview of the approaches that have been successfully employed by a number of state and local governments to deal with this new environment and to provide practical guidance on how to implement these approaches. This summary will identify the issues and present a guide to using the supplemental documentation. To this end, three current topics that have proved to be difficult or contentious will be addressed:

- **Designing a telecommunications network**
- **Leasing vs. Owning a network**
- **Using public ROW to obtain telecommunications**

## Designing a Telecommunications Network

Traditionally, traffic signals have been connected to the operations center via standard telephone lines through a dedicated or dial up connection. This is a very simple network using straightforward technology. Today, with the deployment of video cameras, variable message signs, and advanced surveillance systems, the amount of data being transmitted has grown by orders of magnitude. Further, the technologies available to transport this data are expanding at a similar rate. The result is an increase in the complexity of the network to interconnect the devices and the number of ways, or architectures, that might be used for this connection. **Therefore, it is important that a thorough systems engineering study be undertaken before embarking on the deployment of a telecommunications network.** The State of Maryland has just completed a telecommunications analysis, and Reference 1, *"A Case for Intelligent Transportation System (ITS) Telecommunications Analysis"*, presents the process as well as the lessons learned from the study.

The Maryland State Highway Administration's (SHA) Chesapeake Highway Advisories for Routing Traffic, (CHART) program has been underway for several years defining and testing options for the deployment of ITS technologies in Maryland. In this process, they needed to expand their telecommunications capability. Using their traditional consultant cadre, they laid out a network architecture that connected a number of TV cameras, VMS's, and other equipment to their statewide operations center. This network served them well and accomplished all their objectives. However, when they were ready to expand their program and their network statewide, SHA decided to do an analysis of leasing vs building the complete statewide telecommunications network. (This is a subject that will be covered subsequently.) It was found that the technical capabilities of their normal transportation consultants needed to be enhanced with an expert in telecommunication networks. Therefore, the SHA hired a company whose expertise was in sophisticated telecommunications networks for this task, who then worked with the traditional transportation consultants.

## Compressed vs. Broadcast Quality Video

The first task the telecommunications consultant set upon was the determination of the requirements for telecommunications. Although SHA had defined the location of all their roadway devices, e.g. cameras, loops, radars, VMS's, pavement and weather sensors, etc., they had not decided who should receive what data, how often, and at what quality. The list of users of the transportation data is extensive; a State Operations Center; 4 modal administration headquarters; 7 district offices; 6 Traffic Operations Centers; 35 maintenance facilities; 9 State Police facilities; Interstate park and ride lots; and the Baltimore and Washington DC broadcast media. The network to serve those needs is extensive. Therefore, the consultant interviewed all of these offices to determine what data were needed, how often, and at what quality. The quality issue is associated with the distribution of video to the potential users. Since video is by far the most demanding in terms of bandwidth or data rate, it is crucial to determine if broadcast quality video was required or if compressed video would do the job.

To evaluate the video quality issue, the consultant gathered several hours of traffic video. Both broadcast quality and 100 to 1 compression were used in gathering the data, and then a side by side comparison was made to show the users in the state. The users were asked if the compressed video was of sufficient quality to meet their needs. These users were the people who would actually use the video on a day to day basis. The result was that compressed video was determined to be quite adequate to perform all the tasks defined. This conclusion was based on the fact that the most noticeable affect of video compression is the slightly jerky motion of moving vehicles. Yet, the quality of the pictures of the roadway and the surrounding environment were of virtually the same quality. This permitted the evaluation of incidents, as well as determining the condition of the roads in a variety of weather conditions. Further, the video was deemed acceptable by the local TV stations for broadcast.

There were several lessons learned through this experience. First, the vast majority of the individuals who must use the data had never seen compressed video, or seen the two side by side. Secondly, the question usually asked of those users that had seen both was " which do you like best?", which would result in a different answer from "which will serve your needs." There is a difference between compressed and uncompressed video, however the difference is not as great as some might think, obviously not different enough to be significant for the transportation functions that SHA had defined. However, the difference in the telecommunication requirements are substantial. Compressed video takes one hundredth of the bandwidth of broadcast quality, and will demand a completely different technology to connect to the network. This translates into a major decrease in cost for equipment, whether one leases or builds, and a significant decrease in the cost of leasing, when that option is being considered.

**Defining the network**

Having defined the video needs and which functional entity needed what data, it was then feasible to consider the design of the telecommunications network. In this process, there were a number of alternatives that required exploration. First, the network configuration that would be optimum to build would be very different from a network designed to take advantage of private industry's existing infrastructure . To take advantage of private infrastructure requires a knowledge of where and what those facilities are. Telecommunications companies have facilities, e.g. hardware hubs, switches, major nodes with various capabilities, i.e. bandwidth, located through out their service area. Taking advantage of these capabilities might mean aggregating feeds from field devices much differently than if fiber had been located along the highway ROW. This approach is more likely to lead to a distributed network configuration. Whereas, if a DOT is building a network laying fiber in their ROW, a more centralized network is a common configuration; a fundamentally different architecture.

In addition, one must consider potential combinations of building and leasing, which produces yet another architecture; and, since Maryland already owned 75 miles of fiber, the use of that fiber had to be factored into the configurations. The result is that there is a multiplicity of network architectures that must be evaluated in this process. This is where a real telecommunications network expert is required. In SHA's case, this process resulted in the evaluation of 22 network configurations, all of which would meet SHA's requirements. Although each State is unique, there will be a variety of configurations that will meet the needs of any state. Factors such as the density of field devices, location of all network nodes, how much bandwidth is required, etc., will affect the network architectures that are appropriate for a particular state.

**The Build vs. Lease Decision**

The network architectures, defined in the analysis described previously, will have defined the location of all devices, nodes, users and other network elements that are required to describe the capacity required throughout the network. This data now permits a cost tradeoff analysis to be performed on the options of building or leasing the required telecommunications capacity. .

There are several important issues that must be considered in the performance of this analysis. First, the analysis should be a "life cycle " cost analysis. This means it must consider all elements of cost that might be incurred to design, implement, operate, and maintain the network over a designated period of time; at least ten years to allow for the amortization of the equipment purchased. If an analysis is performed beyond ten years, the cost of a technology upgrade will likely be necessary to obtain a realistic picture. Maryland, chose to evaluate over a 10 year period.

Other key factors affecting the cost tradeoff analysis are the reliability and availability required of the network. The DOT must decide how much down time can be tolerated over a specific time period, and the maximum allowable time to restore the network to operation after a failure. These factors will affect the amount of redundancy required, if any, or the level of fault tolerance built into the equipment. Maryland required an availability of 0.99 and a maximum restoration time of 4 hours. Whereas, the Houston Metro requirement is for a 0.9998 availability, a factor of 50 more stringent, and a maximum restoration time of 2 hours. These factors can have a significant affect on the cost of hardware, the structure of the network, as well as the level of maintenance required, another key cost driver.

When performing this analysis, it is necessary to obtain as much actual cost data as possible, or to obtain quotes for hardware and services, this is especially true for lease costs. The rapid change and expansion of competition in the telecommunications industry, means that using published tariffs for leasing rates is almost always an overstatement of those costs, and sometimes it is substantial. How large that overstatement is, is a function of the local conditions. In SHA's effort, they received multiple quotes from telecommunications providers for the leasing costs for all the actual network configurations defined in the process noted above.

The life cycle cost tradeoff analysis requires a well defined methodology to ensure that all relevant factors are considered. To assist others in this process, a detailed methodology for the conduct of this analysis is contained in Reference 2; " *ITS Telecommunications; Public or Private? A Cost Tradeoff Methodology Guide.* "

**Tradeoff results**

The results of this analysis were a major surprise to SHA. Midway through the analysis, it became clear that the cost of building an entire statewide telecommunications network was prohibitive. Therefore, they decided to focus the tradeoff on hybrid configurations that included the option of building or leasing in the major metropolitan areas of Washington D.C., Baltimore, and Frederick Md., where the density of devices might justify the expense of a build option. The rest of the state's network would be a leased configuration. This metropolitan area accounted for 188 miles of roadway out of the 546 miles in the state, but contained 64% of the over 2000 devices on the roads.

When they compared the lowest cost hybrid options from each scenario, "build" scenario was 30% more expensive than leasing over the 10 year period. However, the contrast between leasing and building was really more dramatic than these results indicate. The build portion of the option only considered 188 miles of their roads, while the lease option had lease costs for 546 miles of roads. If a direct comparison of just the lease costs vs the build costs, the build scenario was over twice as expensive as leasing , and would have cost Maryland over $70 Million more than their current configuration.

Another interesting result concerned the use of SHA's existing owned network. SHA had 75 miles of fiber in the Baltimore/Washington corridor. They found that the cost of hooking up devices to that fiber, the way it was designed, was slightly more than the cost of leasing to serve this area, even though there were no actual fiber construction costs to be born by this build option. **This emphasizes the need to have an expert design the architecture of the entire network, and carry out an analysis that considers all the costs before any construction is begun, whether the construction is for a State owned network, or for a shared resource project.**

**Length of Lease**

At the outset of this analysis, it was assumed that SHA would seek a long term lease to avoid the past problems of escalating lease costs. However, when the consultant began examining the technologies that were deployed, and planned for deployment by the local telecommunications providers, they recommended that SHA execute only a three year lease. This is a result of the very rapid change in technology in the telecommunications industry. In Maryland, providers are already testing several new technologies that are likely to significantly lower their lease costs over the next several years. The analysis assumed that the costs of leasing stayed constant over the ten year period; whereas, the probability is that the lease costs will tend to go down because of technology and competition, which will only make the difference between the cost of building and leasing more dramatic.

The results of this controlled study in Maryland, along with similar early results from other areas argue strongly for adherence to the following guideline:

> ***In the fast changing area of telecommunications, DOT's must do a sound network design followed by a technical and cost analysis, before investing scarce capital resources.***

It is recognized, that the results obtained by Maryland are not directly transferable to other states or communities. Local DOT needs and the local telecommunications environment are the driving factors in such an analysis. However, in order to assist states in this process, FHWA will be sponsoring a one day seminar on the methodologies presented in these references, which will be presented by Maryland SHA officials and Computer Sciences Corp., their telecommunications consultant. The contact for more information is William S. Jones, the ITS Joint Program Office, U.S. DOT, Tel. 202-366-2128.

**Using ROW to Obtain Telecommunications Infrastructure**

In many states there are opportunities to obtain portions of their telecommunications network by bartering access to state or locally owned highway Right Of Way (ROW) to telecommunications companies. In other words, share the ROW resource with private telecommunication providers; in exchange for free service or infrastructure, thus the term *"Shared Resources"*.

A number of states have successfully engaged in this process gaining significant portions of their network in this fashion. This can be done in a number of ways. Some states are using the installation of underground fiber optics on their ROW to support data transmission. Others are trading their ROW to support wireless towers in exchange for transmission services from roadway devices to their network backbone.

In large part, the current needs of various kinds of telecommunications providers determines what can be obtained through Resource Sharing verses what will have to be acquired.

References 3&4; *"Shared Resources: Sharing Right-Of-Way For Telecommunications; Identification, Review, and Analysis of Legal and Institutional Issues"*, and *"Shared Resources:*

*Sharing Right-Of-Way For Telecommunications; Guidance on Legal and Institutional Issues"*, provide several case studies on how states and local agencies have accomplished Shared Resource projects.

**Be Prepared**

The preferred approach to this process is to first define the telecommunication needs of the agency and then develop some potential network architectures **before** engaging in negotiations with telecommunications companies. A knowledgeable telecommunications consultant will be able to provide architectures that take advantage of existing private networks, as well as those that would likely be most attractive to private industry. This prepares the State to define its requirements and provides private industry with the information they need to prepare an appropriate response. It also raises the probability of favorable responses.

However, several states have entered into Shared Resource projects without doing the analysis defined above. This may produce quite satisfactory results gaining the state a valuable telecommunications capability during a perceived limited time when telecommunications providers wanted to build new , or expand existing networks.. However, this may not always be the case.

For instance, Maryland completed a Shared Resources deal obtaining fiber capacity along the Baltimore/Washington corridor, before any of the analysis defined above was undertaken. When the cost tradeoff study was performed they found that it was slightly less costly to lease service than to hook up to the fiber they already owned. This is due to the configuration of the network using the fiber, and the cost of hooking up devices to the fiber. Therefore, to maximize the value of a Shared Resource project, it is important to define the network requirements before engaging in negotiations with private industry.

**Act When the Market Peaks**

Shared Resource projects can be time sensitive ventures. When the telecommunications market conditions warrant, a deal might be possible. However, a state or local government must be prepared to move when the opportunity presents itself or the private company may go elsewhere to obtain access to ROW to suit its business needs. Having acknowledged the time issue, there is usually enough time to allow a 3-6 month analysis effort to help define at least the needs and some networking alternatives.

**Other Issues**

In addition to technical issues discussed above, there are a number of difficult non-technical issues that must be addressed to conclude a Shared Resource project. FHWA sponsored a detailed study of several Shared Resource projects and analyzed seven perceived issues that seemed to be the most difficult or contentious. In actual fact several of these issues were found to be relatively inconsequential. The seven issues examined are:

- Public sector authority to receive and/or earmark compensation.
- Exclusivity- under what circumstances might a single telecommunications provider he granted exclusive use of the States ROW.
- Valuation of public resources - how can the value of the government's ROW be determined.
- Compensation - what are the compensation approaches and their relative merits.
- Liability - who is liable for system repair and tort actions.
- Tax issues - what are the tax implications in a Shared Resource project?
- Relocation - allocation of responsibilities in the event of roadway improvements.

Although these issues may not have been previously addressed in a particular state or community, it is noteworthy that several states have successfully dealt with them in a variety of ways. **In today's expanding telecommunications market, Shared Resource projects are possible.**

To assist state and local governments in Shared Resource projects, FHWA has published the results of the study mentioned above that suggests approaches to each of the issues and how other states have dealt with them. This report, in both summary form and the full detailed final report are contained in References 3&4. In addition, FHWA has been offering workshops covering similar material for those states interested in Shared Resource projects. The approximately 19 states that have received these workshops have found them most useful. For more information, contact William S. Jones, the ITS Joint Program Office, U.S.DOT, Tel. 202-366-2128.

Another useful study on Shared Resources is that performed by the Office of Program Review in FHWA. The review team did in depth reviews of Maryland's and Missouri's Shared Resource programs and provide a different perspective on the issues. This data is provided in Reference 5, "*Longitudinal Utility Accommodation: Case Studies for Trading Access to Freeway ROW for Wireline Telecommunications*"

**The Telecommunications Act of 1996 (TCA)**

The TCA has had, and will continue to have, far reaching affects on the telecommunications industry. This process can be viewed as an opportunity for state and local governments in satisfying their telecommunications needs.

A cautionary note----

The TCA reaffirmed the rights of state and local government to manage and control access to their ROW. However, the TCA also said that in so doing, states must do so in a "non-discriminatory and competitively neutral" manner. Therefore, before a state enters into a Shared Resource project, or decides to own its telecommunications infrastructure, it would be wise to consult legal counsel on the implications of the TCA and the proposed course of action. Reference 8, "*Effects of the Telecommunications Act on Utility Accommodation*", provides guidance from FHWA on one facet of the implications of the Telecommunications Act regarding Shared Resource projects.

The discussion of ROW is contained in Section 253 of the Act, which deals with "Barriers to Entry". This section, in effect, says that state and local governments can do nothing that has the effect of inhibiting competition in the telecommunications industry. The FCC does not plan to issue rules on this section. However, there are already pleadings before the FCC on the meaning of "Barriers to Entry", and what states and local governments may or may not do in conformance to this section. State and local governments should follow these proceedings closely, and if so inclined, provide comments to the FCC on these issues.

**Referenced Documentation**

1. *A Case for Intelligent Transportation System(ITS) Telecommunications Analysis :* FHWA- JPO-97-0015

2. *ITS Telecommunications; Public or Private? A Cost Tradeoff Methodology Guide:* FHWA-JPO-97- 0014

3. *Shared Resources: Sharing Right-Of-Way For Telecommunications; Guidance on Legal and Institutional Issues:* FHWA-JPO-96-0015

4. *Shared Resources: Sharing Right-Of-Way For Telecommunications; Identification, Review, and Analysis of Legal and Institutional Issues; Final Report:* FHWA-JPO-96-0014

5. *Longitudinal Utility Accommodation: Case Studies for Trading Access to Freeway ROW for Wireline Telecommunications":* FHWA, OPR 96-06

6. *Guidance on Sharing Freeway and Highway Rights-of-Way for Telecommunications:* AASHTO

7. *Policy Guidance: Section 301 of the National Highway System Designation Act of 1996.*

8. *Effects of the Telecommunications Act on Utility Accommodation: FHWA, Office of Engineering: oct. 25, 1996*

Publication No. FHWA-JPO-97-0019
HVH-1/2-97 QE