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**Research and
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Intelligent Transportation Systems Telecommunications Infrastructure Forum

April 27, 1995

Volpe National Transportation Systems Center
Cambridge, Massachusetts

Summary Proceedings from

ITS Telecommunications Infrastructure Forum
Volpe National Transportation Systems Center
Cambridge, MA

April 27, 1995

Introduction

On April 27, 1995 a group of 35-40 representatives from telecommunications companies, state and local transportation agencies, and consulting groups where brought together by the U.S. Department of Transportation's ITS Joint Program Office and Volpe Center to discuss their roles, and the factors influencing decision-making in the deployment of fiber optic telecommunications infrastructure to support the needs of transportation agencies. Background information on ITS and related telecommunications issues is contained in the overview section of the proceedings. Douglas Melcher of the Massachusetts Institute of Technology prepared the summary of the day's discussions which focused on seven major topic areas. Following the summary of proceedings is a synopsis of additional 'post meeting' thoughts of five participants. The rest of the document is the briefing book -- a compilation of articles and other information -- which was provided to participants prior to the workshop.

Overview

Advances in computers and communications provide an opportunity to improve the nation's transportation system. Applications such as traffic control and commercial vehicle management can improve vehicle flow, reduce environmental impact, and enhance economic productivity. Generally, these applications are described as Intelligent Vehicle Highway Systems or Intelligent Transportation Systems (ITS). To meet the communications needs of ITS, many state and local transportation agencies are deploying fiber optic networks that provide broadband, reliable, low cost communications.

As these developments are occurring, technological advances are also driving investment in the National Information Infrastructure (NII). Telecommunications companies are deploying fiber optic networks to meet paying customer demand for communications capacity. Deployment is being accelerated by industry-wide competition for market share.

Deployment of large scale land line networks requires access to right-of-way for cable placement. Transportation authorities are uniquely endowed in this regard because they typically control right-of-way that spans wide geographic regions. They are well suited to deploy owned infrastructure or to provide access for private telecommunications networks. Nationally, for example, the interstate highway system extends across more than 100,000 miles of roadway.

Transportation agencies have three basic options for obtaining fiber optic communications capacity including (1) lease communications capacity from a private service provider, (2) build an owned system, or (3) leverage access to right-of-way by facilitating public-private development partnerships. Each of these approaches has various advantages and disadvantages which were explored during the forum. Several case studies which examined the key factors in lease/own decisions served at background material for the forum participants.

Lease Vs. own

Several key decision factors influencing lease/buy decisions were identified by forum participants. These factors included cost, reliability, operations and maintenance, and resource availability. Among these, cost was the foremost decision factor. The case studies revealed that transportation agencies often rely upon in-house expertise to assess the cost effectiveness of lease/own options. However, in many instances, agencies solicit the advice of outside consultants to inform the decision making process.

Many transportation agencies deploying ITS are developing owned fiber optic networks because leasing is not perceived to be a cost effective alternative. At the forum, Bruce Abernathy of Kimley-Horn & Associates presented survey results demonstrating the high percentage of jurisdictions that already own fiber telecommunications networks for ITS. As noted in Table I, roughly 67% of traffic signaling systems and 84% of freeway systems use fiber networks that are owned.

Table I - Owned/leased fiber optic systems

Traffic Signal Systems		**Freeway Systems**	
% Owned	% Leased	% Owned	% Leased
67%	33%	84%	16%

Agencies have characterized the decision to own rather than lease as "obvious" because broadband capacity is typically very expensive to lease. For example, project planners for the Central Artery / Third Harbor Tunnel project (see case study) noted that there was no cost alternative to procurement when the decision to own was made in 1990, and "its difficult to imagine one right now."

A cost analysis prepared by Abernathy supports the assessment that owning can be more cost effective than leasing. The analysis demonstrated that under certain conditions an owned fiber system will pay for itself after just a few years of operation. However, leased services may be justified in circumstances where wide area network links or temporary service is required.

Rising leasing costs are also an important factor. Transportation agencies, such as San Jose's Department of Streets and Parks, are actively developing owned systems to avoid the uncertainty of future leasing costs.

Several forum participants, including Pat McGowan of TxDOT and Gene Donaldson of Montgomery County, pointed out that if leasing were really more cost effective than owning, their agencies would have chosen the leasing alternative to save money. Generally, if there is a less expensive way of obtaining telecommunications capacity, transportation agencies are very interested.

Forum participants from the telecommunications industry generally argued that many important "hidden costs," such as operations, maintenance, and upgrades are neglected in typical cost analyses of lease/own options. Hunter Shaw of TCI argued that if the hidden costs of owned systems are taken into account, leasing is the more cost effective alternative. The entire life cycle costs of deployment, including future upgrades, must be examined.

Many transportation agencies also expressed concerns about the reliability of telecommunications services and noted that this was an important decision factor. For example, Bay Area Rapid Transit chose to deploy its own telecommunications network, the BART Telesystem, in part because relying upon a third party in an emergency was considered highly undesirable. A strong belief was expressed that for the health, safety, and welfare of the transit system, leasing would be undesirable. Operating and maintaining the system protects against undesirable situations where a third party may fail to respond quickly enough to service outages.

However, not all transportation agencies are convinced that they are better positioned to ensure system reliability than private sector providers. For example, the Missouri Highway and Transportation Department noted that system reliability could best be ensured by using services offered by a private sector provider because the state does not have the expertise to perform operations and maintenance (see case study). Arguably, the telecommunications industry already handles many mission critical applications, such as telemedicine, and is therefore quite capable of ensuring network reliability.

Generally, state and local transportation agencies are wary about getting into operations and maintenance of telecommunications networks but will do so it if it can save money. Agencies already operating or building owned fiber networks are confident about their ability to handle system operations and maintenance. Donaldson noted that his agency has been successfully upgrading its technology for decades. However, the talent required to deploy, operate, and maintain advanced telecommunications systems is scarce.[1]

Resource availability was another key decision factor. In many jurisdictions, the need for bandwidth for ITS is ahead of private sector deployment. For example, Thomas Dengenis of the Massachusetts Highway Department noted that NYNEX simply could not provide the level of service required for Boston's Central Artery / Third Harbor Tunnel project. And Pat McGowan of TxDOT noted that the system capacity was simply not available to support ITS needs in San Antonio. However, there was some question as to whether or not transportation agencies really need telecommunications capacity now or can wait for the private sector to deploy more fiber. It may be that the private sector needs to be more ambitious about educating the public sector on the subject of private sector service offerings. Doug Wiersig of the City of Houston argued that the public sector may not know all of the options that are available. For example even if owned systems are developed, transportation agencies should consider using private sector networks to provide redundancy to promote network reliability.

Funding

Regardless of whether telecommunications capacity is leased or owned, obtaining broadband telecommunications capacity is expensive. Whenever possible, transportation agencies prefer to find options that do not require new funding allocations from legislatures. Even if fixed costs for initial deployment can be met, on-going costs associated with leasing or operations and maintenance can be considerable and subject to uncertainty. Typically, transportation agencies have difficulty meeting on-going costs because public funding is erratic.

One forum participant noted that it is very difficult for a transportation agency to ask for more public funding to pay for services that a legislature believes it has already paid for. Public agencies may find it easier to obtain funding for operations and maintenance costs than leasing expenditures.

Procurement

Public sector procurement and budgeting processes may be in conflict with private sector bidding and pricing strategies. In some states, the legal framework does not permit contract periods greater than 5 years and requires awards to go to low bidders. Forum participants suggested that, given time, the private sector would be able to develop pricing strategies to accommodate public sector needs. Public transportation agencies that solicit requests for

[1] Earl Hurd of Bell Atlantic made this point.

proposals should identify functional requirements for deployment rather than fixed technical strategies.

Shared resources

Transportation agencies can leverage right-of-way to obtain leasing revenue or communications capacity from the private sector. Susan Jakubiak of Apogee Research presented an overview of the key issues that arise in shared resource projects including valuation of public resources, exclusivity of right-of-way, tax implications, relocation fees for future construction, and liability.[2]

Joe Baybado of Bay Area Rapid Transit described a unique public-private partnership that his agency recently arranged with MFS Network Technologies (see case study on BART) to provide a revenue stream for the transit authority. The arrangement provides a built-in funding mechanism for BART by leveraging control of strategic right-of-way through leasing arrangements. Baybado noted that the joint development approach was the only feasible option for BART because, like many transportation agencies, public funding for large scale projects is not available.

There are a variety of approaches for evaluating the monetary value of access to public right-of-way including competitive auction, valuation of adjacent land, cost of next best alternative, needs-based compensation, and historical pricing. In general, the value of right-of-way depends upon its exclusivity and location.

Under shared resource agreements, bonds which are issued to fund transportation projects may not be tax-exempt as is usually the case. A bond is defined as a private activity bond, which is not tax exempt, if more than a certain percentage or amount of the proceeds are for private sector use.

Future transportation construction may require relocation of infrastructure deployed in the right-of-way. Shared resource arrangements must assign responsibility for paying the cost and managing relocation of infrastructure when improvements require relocation. For the Ohio Turnpike, a standard license agreement requires relocation at the license holderUs expense. Alternatively, the Missouri Highway and Transportation Department pays for relocation in circumstances of highway expansion or maintenance.

The legal liability of participants in shared resource agreements is also an important issue. Generally, the partner that is responsible for causing damages pays for repairs.

Shared resources revenue

Not all transportation agencies are allowed to keep the revenue generated by right-of-way leasing arrangements. Where the money goes depends upon state law. Unfortunately, there is little incentive for transportation agencies to pursue shared resource arrangements if the money simply goes back to the general fund. Most municipalities and many states require generated revenue to go back into the general fund. This is in part because having the money go into the general fund helps the bond rating of the jurisdiction. Joe Baybado of BART suggested that the FHWA should develop strategies to ensure that state and local agencies will have an incentive to develop shared resource projects.

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[2] Apogee Research is preparing a report on shared resources that addresses these considerations in detail.

Bandwidth

Forum participants disagreed about the purported communications capacity requirements of ITS. Bruce Abernathy of Kimley-Horn & Associates suggested that the "ITS Freeway Communications Data Load" is on the order of 12.5 Mbps per mile and that the "communications demand for ITS systems will continue to grow.

Christine Johnson of USDOT asked the forum participants to comment on the capacity requirements suggested by Abernathy.

Several representatives from telecommunications companies expressed skepticism about the purported bandwidth requirements of ITS. A representative from NYNEX suggested that high bandwidth is not required because distributed intelligence allows traffic management systems to use very little communications. Hunter Shaw (TCI) noted that although transportation applications may be developed to use the available bandwidth there may not be an actual need for the applications. This called into question the need for wide scale deployment of surveillance systems which are central to many ITS projects.

However, Pat McGowan of TxDOT argued that there is no question about the need for channel capacity for ITS because new systems going on line demonstrate the need. Gene Donaldson of Montgomery County stated that the experience of his agency has been that the bandwidth requirements are real and that broadband capacity is being used now. Many of the case studies examined by staff at the Volpe Center support these two assessments.

Reserve and excess capacity

Transportation agencies typically build reserve capacity to support future ITS telecommunications needs. However, in some instances states and localities are building fiber capacity to support broader governmental purposes, a practice that traditional service providers view as a potential competitive threat. For example, Montgomery County is building a "FiberNet" that will serve the communications needs of the Department of Transportation, Montgomery County Public Schools, and a multitude of County functions.

Telecommunications companies are concerned that ITS deployments will generate vast excess capacity that will ultimately be turned over to third parties who will then forego private sector services. Bell Atlantic is very concerned that flawed costs analyses will lead to a migration from transportation telecommunications systems to the development of general state telecommunications networks. However, Bruce Abernathy of Kimley-Horn & Associates pointed out that transportation departments generally don't want to support the broader telecommunications needs of state and local governments. Concurring, Thomas Dengenis of the Massachusetts Highway Department argued that his agency is not interested in serving the broader telecommunications needs of the state.

Telecommunications industry

Changes in the national telecommunications regulatory structure, due to judicial and congressional action, will promote competition in the telecommunications services market. For example, telephone companies may eventually compete to provide video services to the home as a consequence of the elimination of cross ownership restrictions. Future telecommunications costs are likely to decrease as technological advances and competition influence the market.

Henry Kelly of the White House Office of Science and Technology Policy noted that the federal governmentUs NII policies will have a profound impact on the development of ITS. The AdministrationUs goal is to facilitate the efficient deployment of information infrastructure and ensure that important principles, such as universal service and non-discriminatory access/ interconnection, are upheld.

Competition means that new telecommunications services will be available in the future that could support the needs of ITS according to Bob Avin of AT&T. Increased local competition could also impact the cost effectiveness of lease/own options. However, asked if the entry of new competitors into the market would make the right-of-way more valuable, a forum participant answered "perhaps." As Hunter Shaw of TCI pointed out, firms wonUt build networks if it isn't possible to capture a sufficient return on the investment. Speculation suggests that coalitions of firms may work together and share network infrastructure. Shaw suggested that it may not make sense for cable and telephone companies to over build each other with duplicative fiber networks.

Conclusions

Although forum participants seemed to agree that the meeting facilitated the exchange of valuable information between the public and private sector, there was very little general consensus on the main discussion issues. Most participants seemed to agree that transportation agencies will use large amounts of bandwidth, although some were skeptical about the actual need. The transportation agencies represented at the meeting argued that owning is more cost effective than leasing and right-of-way is an important public asset. Telecommunications companies generally argued that when Rhidden costsS such as operations, maintenance, and upgrades are considered, leasing is more cost effective than owning. Many conference participants voiced the opinion that there is a real need for public-private partnerships to promote ITS telecommunications development. Lee McKnight of MIT mentioned many of these key issues during a summary presentation at the end of the forum.

Christine Johnson of USDOT asked conference participants if there is anything that the federal government can do to encourage public-private partnerships. The FHWA could potentially impact the decision making in transportation agencies leveraging its role as a funding source for state and local transportation projects. However, Pat McGowan of TxDOT commented that partnerships can't be developed with mandates at the federal level. At this time, the appropriate federal role in fostering public-private partnerships is rather unclear.

Johnson requested conference participants to submit further commentary on the subject of lease/own tradeoffs and suggested that a follow-up meeting might be appropriate.

A Summary of the Responses to Christine Johnson's Request to Share Views after the ITS Telecommunications Infrastructure Forum

At the April 27, 1995 **ITS Telecommunications Infrastructure Forum** held at the Volpe Center in Cambridge, MA, Dr. Christine Johnson asked the attendees to think about the day's discussions and share with her any additional ideas, views, or perspectives. The following summary reflects the views of the three public sector users/consumers, one private sector provider of telecommunications services, and one consultant who provided written comments.

A common theme of the responses emphasized the need for continued dialogue among "the players," though some respondents limited the group to state and local governments and the telecommunications companies while others included the public utility companies and cable television providers. Public agencies expressed the "need to continue to participate at a national level in dialogues around this issue," and the telecommunications company described a particular partnership agreement that "could provide a good discussion base at a future forum."

One of the principal reasons for the need to continue a dialogue, centers on the disagreement over the most fundamental of market issues --- supply and demand. The public sector seems largely agreed that they have enormous bandwidth requirements, and are eyeing all sources of capacity, from leased to owned installations, as well as the under-utilized capacity that may exist with public utility companies. Meanwhile, the telecommunications companies appear hesitant to believe that ITS requirements are so great, and assert that they can be met without additional fiber, while understanding that this could be a lucrative market if it comes to pass. Further, in their view, the many public agencies that have installed their own fiber have probably mis-estimated total costs.

The public agencies recognize their chief asset to be rights-of-way and are interested in identifying valuation strategies. Given their limited data rights to information flowing over the network, the commercial use of the infrastructure is what appeals most to some public sector participants. They are looking to the U.S. DOT/FHWA for help in the formation of model contracts, the loosening of procurement and funds restrictions, and enhanced local agency control. (The issue of local decision-making was also picked up in a response from a participant in the telecommunications industry.) A significant share of the public agencies view ownership of their own fiber networks as certainly cheaper, and perhaps profitable, compared to leasing, which contrasts with the prevailing industry opinion. There is, as a result, a perceived need for a review of benefit/cost analysis, given the significance of the investment and the changes in the competitive environment. One response noted the feeling that "FHWA's role should be one of facilitator not regulator." and suggested that FHWA help "in dealing with FCC or other regulating bodies...where appropriate."

There is no apparent agreement on whether rights-of-way are a public good. per se. to be exploited by other public or private groups. or a commodity to be used at the sole discretion of the transportation sector. State laws differ in this area. and thus provide a range of incentives or disincentives to generate revenues from communications networks. There is, however, general agreement that there are great benefits to deployment. and delays are equated to lost opportunity for governmental savings. foregone public benefits due to congestion and lost revenues to service providers. whoever they turn out to be.

The result was interest from all participants in finding ways to foster constructive partnerships and remove impediments, to "explore our current policies, regulations and state laws regarding barriers...to allow for the deployment of telecommunications via public/private or private infrastructure."

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9:00	Registration / Informal Networking	
9:15	Opening Remarks and Introductions	Richard John
9:30	Forum Purpose and Overview	Christine Johnson
9:45	ITS/ATMS Telecommunication Infrastructure Requirements / Options	Bruce Abernethy Discussion Leader
	What telecommunications capabilities do transportation agencies need for ITS/ATMS? *How significant is telecommunications in ITS plans?* *What can agencies look to the market to provide?*	
10:45	Changing Nature of Telecommunications Industry	Carol Zimmerman Discussion Leader
	What changes in federal and state regulation are likely? *Will collaboration or competition increase?* *What technological changes are on the horizon?* *How will this effect state and local agencies deploying ITS?*	
11:45	Break for Working Lunch	
12:15	Case Studies: What Lessons Do They Provide	Gary Ritter Discussion Leader
	How do agencies decide on telecommunications solutions? *What are the pros and cons of owned, leased, or shared ITS communications infrastructure?* *Do current ITS telecommunications acquisition planning and decision processes produce optimum results? How might these processes be improved to yield greater public benefit?*	

AGENDA (Continued)

ITS TELECOMMUNICATIONS INFRASTRUCTURE FORUM

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1:15	Shared Resource Opportunities and Impediments *What significant issues need to be resolved to enable private sector telecommunications providers to develop shared resources with state and local governments?*	Susan Jakubiak Discussion Leader
2:15	National Information Infrastructure (NII) Implications	Henry Kelly Discussion Leader
2:45	Next Steps *What Role Should U.S. DOT Play? What Role Should State and Local Governments Play? What Role Should the Private Sector Play?* *What Actions Should Be Taken? Further meetings? A larger, follow-on government-industry conference?* *ITS and/or NII Policy and/or Program Adjustments?* *ITS Telecommunications Acquisition Research and Analysis Needs?*	Lee McKnight Discussion Leader
3:30	Closing Remarks	Christine Johnson

ITS Telecommunications Infrastructure Forum
April 27, 1995

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ITS/ATMS Telecommunication Infrastructure Requirements/Options

Generic Intelligent Transportation Communications Requirements Overview and Solutions

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1.0 INTRODUCTION

Intelligent Transportation Systems (ITS) include the integration of computer operations centers and distributed Field Controllers (FC) into a virtual system which supports ITS services to the public, commercial users, and private users of the transportation infrastructure. FCs support a variety of functions from sensor data collection to communications with users through control of signals, electronic signs, and other information messaging techniques. The major functions of the "virtual system" are to proactively manage congestion, improve traveler safety, reduce operations cost for commercial vehicles, and enhance coordination between multimodal transit operations and users. By minimizing congestion of road and street infrastructure and maximizing convenience of public transportation alternatives for drivers, more efficient use of existing infrastructure is achieved with an associated reduction of environmental pollution.

The term "virtual system" is used because ITS systems must operate in a seamless manner, sharing information across geographic boundaries of jurisdictions, facilitating a single management message to users. ITS corridors must be coordinated with signal control timing, congestion management, emergency management, and alternate corridor establishment conducted in the best interests of all users. This requires real-time information exchange between FCs and operations centers with an emerging requirement of real-time communications between infrastructure and vehicles, and between vehicles.

The "heart" of the ITS system is its modern communications network which supports the virtual extensions of the Freeway, Traffic Signal, and Transportation Management System local area networks (LANs) into the urban, metropolitan, and rural areas. Without a modern communications network to bring back real-time sensor information to ITS operations centers, where conditions of the infrastructure are evaluated in real-time and coordinated between jurisdictional centers, with management decisions translated into communications messages to ramp meters, variable message signs, reversible lane control signs, "Path Finder" alternate route signs, highway advisory radios, FM subband communications to vehicles and corridor signal timing plan adjustments, we would be little better off than we were 50 years ago with mechanical traffic signal controllers. Without a modern, reliable communications network, we would have no "intelligent transportation systems."

2.0 FACTORS ASSOCIATED WITH ITS COMMUNICATIONS NETWORKS

In the past, traffic systems were developed with only a percentage of field controllers integrated with the Traffic Operations Center. The controllers used were relatively simplistic with limited intelligence (typically an 8 bit microprocessor) and limited communications capability (typically 1200 baud). Today's ITS requirements have changed in many ways:

- Advanced controllers (such as the 2070 technology) are significantly more intelligent, can be adapted to many more functions, and can support LAN data rate virtual extensions.

- Alternate corridors are just as important as main corridors in supporting effective congestion management decisions and they are pivotal to congestion management execution strategies.

- Higher density and multiple types of sensors are required to provide an accurate and clear understanding of corridor congestion, incidents, and emergency service needs.

- To effectively communicate with users, a variety of communications paths and techniques are necessary with the latest being direct infrastructure to vehicle communications.

- Sensing and communications must occur reliably day or night and in all weather conditions thus, requiring multiple sensor technologies to be deployed in the field with sensor fusion providing more reliable management answers.

Thus, a transition has taken place. From an era of low speed, low density data communications requirements where leased communications services with dial-up and low bandwidth, were affordable and sufficiently responsive to support traffic control requirements, we have moved into to a new era where wide bandwidth, multimedia, cost effective communications networks are required to support the operational requirements for real-time infrastructure assessment, real-time management decisions and real-time execution of management decisions. We have progressed to the era of ITS where modern systems technologies are being effectively employed to reduce congestion, provide rapid response to emergencies, and provide safer travel for users.

Because we are employing significantly more field controllers and because our operations centers are using state-of-the-art computers, color graphics user workstations, team information display environments (multimedia color wall displays), the interface between the ITS operation center's computers and the communications network has become a further issue. The cost reduction on operations center hardware and software by establishing virtual extension of the LAN has become an important consideration in modern ITS system design. Today, it is unacceptable to bring hundreds of "DS-0" RS-232 channels back to an operations center as was typical of older systems. Information is "groomed" in the field for operations center "computer friendliness" supporting the ability to easily interface the "field environment" with the "operations center environment," manage the network, and responsively detect and correct problems.

It is not uncommon on a large metropolitan ITS freeway to have 30 field controllers per mile of freeway. It is also common to have two or more real-time video sources per mile of freeway for traffic surveillance, congestion analysis, incident detection, and enforcement (controlled HOV lanes). This equates to a basic communications network interface of 136 Mbps per mile, which is of course reduced by multiplexing and switching, but is still significant.

Similarly, the typical jurisdictional traffic signal system being deployed today, emphasizing ITS service objectives, includes video surveillance of major corridors and problem intersections, variable message signs for corridor management, kiosk terminals at convenient locations for public transit users, park-and-ride locations with video surveillance, and variable message signs to communicate with departing drivers, and should include planning to support automated route guidance. Thus, even small jurisdictions with 100 to 150 field traffic controllers are deploying 10 to 20 surveillance closed circuit TV cameras and perhaps 20% additional, ITS field controllers. Thus, the basic level of data communications necessary for this small jurisdiction has mushroomed from a past era of 180 Kbps communications network interface to over 900 Mbps (over a 5000% growth based on DS-3 video codec). While multiplexing techniques and switching techniques used by the ITS communications designer reduce the communications network data load, the point is that communications requirements have significantly increased from the past where perhaps ten, 1200-baud circuits were satisfactory to meet system communications requirements.

The above examples do not include possible future communications requirements between infrastructure and vehicle, which may well emerge as microcellular using direct sequence spread spectrum technology with CDMA protocol, supporting all communications at from 500 Kbps to 1 Mbps.

We are in the infancy of a communications age revolution. Users are mobile and require accurate information in very understandable form (emphasizing color/graphics user interfaces). ITS initiatives have proven, through field testing, to meet operational objectives of proactive congestion management. Automated route guidance provides the most effective means of proactive congestion management with the additional benefit of enhanced driver safety through positive hazard warning communications and "may day" features. And, users of modern ITS technology ***are*** willing to pay for reduced delay and improved safety and security. Thus, the user demand for ITS technology is expected to grow, continuing to stress the need for wide bandwidth multimedia communications within ITS systems.

2.1 Why Communications Reliability Is Critical

With ITS supporting real-time communications from field to centers, between centers, and to infrastructure and transportation services users, loss of communications becomes a critical issue. Similarly, many Regional Transportation Districts (RTDs) play a major role in civil defense, again emphasizing the need for a highly reliable communications network. With route guidance, "may day" and real-time hazards warning capability emerging within ITS service support requirements, driver safety and security become an issue with an unreliable communications network. For these reasons, fault tolerance is being deployed in ITS systems to achieve high reliability in the communications network.

ITS system managers, who are dedicated to rapid detection and rapid response to user emergencies, are monitoring and managing their communications networks. Through the use of network management protocols and positive management, they are assuring that network failures, corrected through fault tolerance, are responsively repaired to maintain network reliability.

3.0 COST COORDINATION

In ITS system designs analyzed by Kimley-Horn and Associates, Inc., the field controllers and devices typically consume 30-35% of the system cost and the communications network consumes 45-50% of the cost. These cost percentages generally are independent of system size and are typical of systems having 100 to 3500 field controllers.

In any ITS system design, the requirements are analyzed, jurisdictional consensus obtained in relation to requirements, design trade-offs made (including life cycle cost), and final system architecture and approach reached. Typically, a survey is conducted of available communications services with associated coverage, interconnect cost, reliability, and bandwidth lease cost. Typically, all jurisdictional needs for real-time "operations control" communications are considered, thus justifying a common network cost savings for traffic, public transit, law enforcement, and other municipal services (such as public water system SCADA).

Since many of the jurisdictional agencies are synergistic with traffic management and close coordination is required, generally an integrated network for the jurisdiction is boh justifiable and economical. Generally, due to the bandwidth required and number of diverse locations requiring multimedia bandwidth support, leased communications services are noncompetitive. In most systems a breakeven cost is achieved in 3 to 5 years when a jurisdiction installs a dedicated communications network, compared with leased service cost for the same period.

There are several trends which support the belief that jurisdiction-owned networks will continue to be the most cost effective solution:

- Optical fiber cost is now less expensive than copper.
- Optical fiber bandwidth (single mode) will meet all jurisdictional planned and unplanned communications requirements.
- Optical network electronics continue to experience cost reductions with greater bandwidth services and modular expansion (can add OC-X increments for growth).
- Optical network technology can meet jurisdictional high reliability needs.

- Suppliers of optical network technology offer very affordable maintenance support options for jurisdictions.

- Jurisdictions are finding that their right-of-ways are valuable assets to the tax payers as a tradeoff for fiber and conduit with private companies desiring use of right-of-ways.

It should be remembered that these communications networks and associated system architectures meet real-time operations and control requirements. They are not for general service communications. They are not in competition with public telephone companies. They are the correct economic choice considering bandwidth, geographic coverage, and service requirements for jurisdictions. Should leased bandwidth cost from public telephone networks be significantly reduced, perhaps a different economic answer would be possible. With the available bandwidth on an existing public telephone, it is perhaps more economical for public networks to serve the hundreds of thousands of users which require DS-0 communications service, rather than pursue the wider bandwidth requirements of ITS.

4.0 SUMMARY

Modern ITS systems require significantly more communications bandwidth and reliability than did past systems. Projections are that bandwidth requirements will continue to grow as new ITS services emerge. The Automated Highway System (AHS), when it emerges, will impact ITS communications. Fiber optic networks support bandwidth and reliability requirements of ITS. These networks are economical when installed by jurisdictions, based on comparative cost of leased services. With the trend of jurisdictions trading right-of-ways for fiber in conduit, adding electronics becomes an even more cost effective choice; however, some leased services, especially for wide area network communications and temporary communications during buildout, are economically justifiable.

A jurisdiction has an obligation to its tax payers to obtain the most cost effective solution available to meet jurisdictional needs. A jurisdiction further has an obligation to tax payers to obtain the "best trade deal" possible for jurisdictional right-of-way use. The ITS segment of the jurisdiction has an obligation to users to meet reliability-of-services needs, assuring that safety and security of users are maximized and congestion on their infrastructure is managed.

Core ITS Infrastructure Elements for Metropolitan Area ATMS/ATIS Deployment

Purpose

This paper presents definitions for a set of seven elements which form the "core infrastructure" for deploying Intelligent Transportation System (ITS) traffic management and traveler information services in a metropolitan area. These definitions constitute today's "state-of-the-art" implementation of ATMS/ATIS, which will establish a foundation for deployment of future ITS user services to be provided by both public and private sector entities. By developing and circulating these definitions, the US DOT intends to focus near-term deployment decisions being made in metropolitan areas, and to maximize future opportunities to implement widespread, advanced ITS user services.

Establishment of the core infrastructure elements permits optimal operations and management of roadway and transit resources through use of currently-available technologies and strengthened institutional ties. In the near-term, implementation of the ATMS/ATIS core infrastructure elements is expected to be lead by the public sector, and development of these capabilities is expected to occur in an evolutionary manner. However, private sector participation is highly encouraged, and appropriate partnership opportunities should be actively sought by State and local implementing agencies. Maturation of the core elements in a number of metropolitan areas can be expected to drive private sector development of products and industries to provide future ITS user services.

This paper defines metropolitan area ATMS/ATIS core infrastructure as consisting of seven elements. These are:

1. Regional Multimodal Traveler Information Center
2. Traffic Signal Control System(s)
3. Freeway Management System(s)
4. Transit Management System(s)
5. Incident Management Program
6. Electronic Fare Payment System(s)
7. Electronic Toll Collection System(s)

Note that the requirements for a number of ITS user services, such as those relating to commercial vehicle operations and vehicle safety systems, are not included in this document since they do not directly relate to metropolitan ATMS/ATIS user services.

Principles Guiding Definitions

In defining these core infrastructure elements, the following principles were followed:

- Deployment of the element(s) will enable meaningful implementation of metropolitan-area ATMS/ATIS user services and facilitate deployment of many other ITS user services.
- Each element could be deployed independently of the others, but concurrent implementation would significantly increase overall benefits and/or decrease incremental costs.
- The element(s) can be readily deployed in the near term using "state-of-the-art" concepts and technologies (versus existing "state-of-the-practice"), and typically would be eligible for Federal-aid funding.
- Varying technologies, from "low-tech" to "high-tech," can be used to deploy/implement each element.
- The definitions should account for different institutional environments, varying spacial/geographic relationships among centers of activity (i.e., as with CBD / ring city / suburb relationship), and recognize that system(s) will evolve over time to provide for greater benefits/lower costs.
- Private sector participation in delivering ATMS/ATIS user services will be encouraged to the maximum extent possible, particularly in the collection and dissemination of traveler information. The private sector is also encouraged to participate in development of the core elements.

Key Considerations for Deployment of the Core Infrastructure

Based on analysis of the unique needs in a specific area, metropolitan regions usually will pursue implementation of some combination of the core elements, eventually leading to a comprehensive ITS. This expected parallel deployment of elements is supported to a large degree by common physical (hardware/software) components and institutional relationships which contribute to successful implementation of more than one core element. These key fundamentals include:

- Capability to distribute multimodal traveler information to the general traveling public
- Surveillance and detection capability; resulting in current, comprehensive, and accurate traffic and transit system performance information
- Infrastructure-based communications systems linking field equipment with central software/database systems
- Communications (routine information sharing) among jurisdictions, between traffic and transit agencies, and between the public and private sectors; without necessarily relinquishing control responsibility (i.e., "share information but not

control") -- This may entail formal interagency agreements for incident response and information sharing

- Information sharing/coordination with emergency medical services, hazardous materials programs, and other appropriate participants
- Proactive management of roadway and transit resources to achieve metropolitan transportation objectives
- Sufficient resources for continuing support of system operations and maintenance needs, including personnel and training requirements

Several of the above points highlight coordination among jurisdictions and agencies within a metropolitan area. The typical metropolitan area transportation system is managed by a diverse set of State and local-level entities, and movement toward implementation of core infrastructure elements will occur at different institutional rates. While it is important for individual institutions/jurisdictions to analyze deployment initiatives to meet their specific needs, many advanced ITS services require wide-scale coordination across jurisdictional boundaries. Where these area-wide approaches are envisioned, enhanced communication and coordination of project development concepts, system architectures, interface standards, design/construction schedules, and operations/maintenance responsibilities and resources is crucial.

In addition to metropolitan-specific deployment, these core infrastructure elements can form the basis for further deployment of related ITS user services in the national transportation network. This growth may be focussed especially on major intercity arterials which are part of the National Highway System. Through appropriate coordination in program development, the core infrastructure elements can support an integrated approach to ITS services such as commercial vehicle systems deployments in major truck network routes, electronic toll and traffic management systems beyond urban areas, and various services along suburban/rural corridors. National compatibility efforts, including application of the emerging national ITS system architecture, will preserve the capability for future expansion, innovation, and advancement of the ITS program.

Definitions of Core Infrastructure Elements for ATMS/ATIS

1. Regional Multimodal Traveler Information Center

The metropolitan area has a repository of current, comprehensive, and accurate roadway and transit performance data. Potential customers and information providers include individuals, business travelers, private sector firms for which transportation service is critical to success, value-added resellers of the information, and public sector entities responsible for transportation system operation and/or safety. Sufficient data is received to provide for ITS user services such as pre-trip and en-route traveler information, such that informed choices regarding mode, route, and time-of-travel can be made by customers.

This repository, either a single physical facility or an inter-connected set of facilities, directly receives roadway and transit system surveillance and detection information from a variety of sources provided by both the public and private sector entities. To a large degree, these sources (and recipients) of information are the other ATMS/ATIS core infrastructure elements. The RMTIC has the capability to combine data from varying sources, package the data in various formats, and provide the information to a variety of distribution channels, including voice or computer services, radio broadcasts, kiosks, etc.

Among the core infrastructure elements, the RMTIC is the key element which provides a bridge between the general public and the transportation system managers. Through linking data from the other elements into a comprehensive regional information system, deployment of these Centers will exemplify movement towards advanced ITS user services. Since these RMTIC's do not currently exist and need to be created in most metropolitan areas, compatibility with the emerging ITS system architecture is essential to assure national interoperability and compatibility.

2. Traffic Signal Control System(s)

Signal control system(s) have the capability to adjust the amount of green time for each street and coordinate operation between each signal to maximize the person and vehicular throughput and minimize delay through appropriate response to changes in demand patterns. At a minimum, these coordinated system(s) will provide for a selection of "time-of-day" signal timing patterns which optimize operations along major arterial routes and throughout signal networks. The capability to adjust the traffic signal timing may include computer-generated timing plans and/or manual operation by a skilled and knowledgeable operator. The hardware/software system(s) are designed to be upgraded in capability as required for future operations with an "open architecture" which enables relatively inexpensive and efficient installation of improved products, and potential coordinated operations with adjacent freeway and arterial systems.

The various jurisdictional systems are capable of electronically sharing traffic flow data with the signal systems of adjoining jurisdictions in order to provide metropolitan-wide signal coordination.

3. Freeway Management System(s)

The freeway traffic managers in a metropolitan area have the capability to monitor traffic conditions on the freeway system; identify recurring and non-recurring flow impediments; implement appropriate control and management strategies (such as ramp metering and/or lane control); and provide critical information to travelers through infrastructure-based dissemination methods, such as variable message signs and highway advisory radio.

The freeway management system(s) includes a Freeway Management Center (or multiple centers where responsibility for the freeway system is shared by more than one jurisdiction) and information links to the multimodal traveler information center and other management and control systems in the metropolitan area. These capabilities can encompass and/or expand to provide for coordination of response to emergency and special-event situations. Examples of proactive management include regular analysis and updating of control strategies, and provision of adequate operations and maintenance resources to support the system's operational objectives.

4. Transit Management System(s)

The transit system(s) in the metropolitan area have implemented fleet management system(s), including hardware/software components on buses and in dispatching centers, software, available radio communications spectrum, operator training, and maintenance. Depending upon needs, the fleet management system(s) would utilize automatic vehicle location, include advanced voice and data communications, automatic passenger counting, driver information (voice and visual), vehicle diagnostics, linkage to geographic information systems, and computer-aided dispatching.

The system provides reliable bus position information to the dispatcher. The dispatcher or a central computer compares the actual location with the scheduled location, enabling positive action to improve schedule adherence and expanded information for transmission to the RMTIC and for direct customer information. In addition, on-board sensors automatically monitor data such as vehicle passenger loading, fare collection, drive-line operating conditions, etc.; providing for real-time management response. In the event of an on-board emergency, the dispatcher can inform the police of the emergency situation and direct them to the vehicle's exact location.

5. Incident Management Program

The metropolitan area has an organized and functioning system for quickly identifying and removing incidents that occur on area freeways and major arterials. The roadway is cleared and flow restored as rapidly as possible, minimizing frustration and delay to the traveling public while at the same time meeting the requirements and responsibilities of the agencies and individuals involved.

The various jurisdictions and agencies responsible for operations and enforcement in the metropolitan area have worked together to develop a policy and operations agreement which defines specific responsibilities for all elements of incident management, including detection, verification, response, clearance, scene management, and traffic management and information. This multi-jurisdictional operating agreement ensures routine cooperation, coordination and communication among all agencies; including enforcement, fire, ambulance, highway traffic control and maintenance, environmental and other public agencies. In addition, private sector participants such as the towing and recovery industry may be involved in clearance.

6. Electronic Fare Payment System(s)

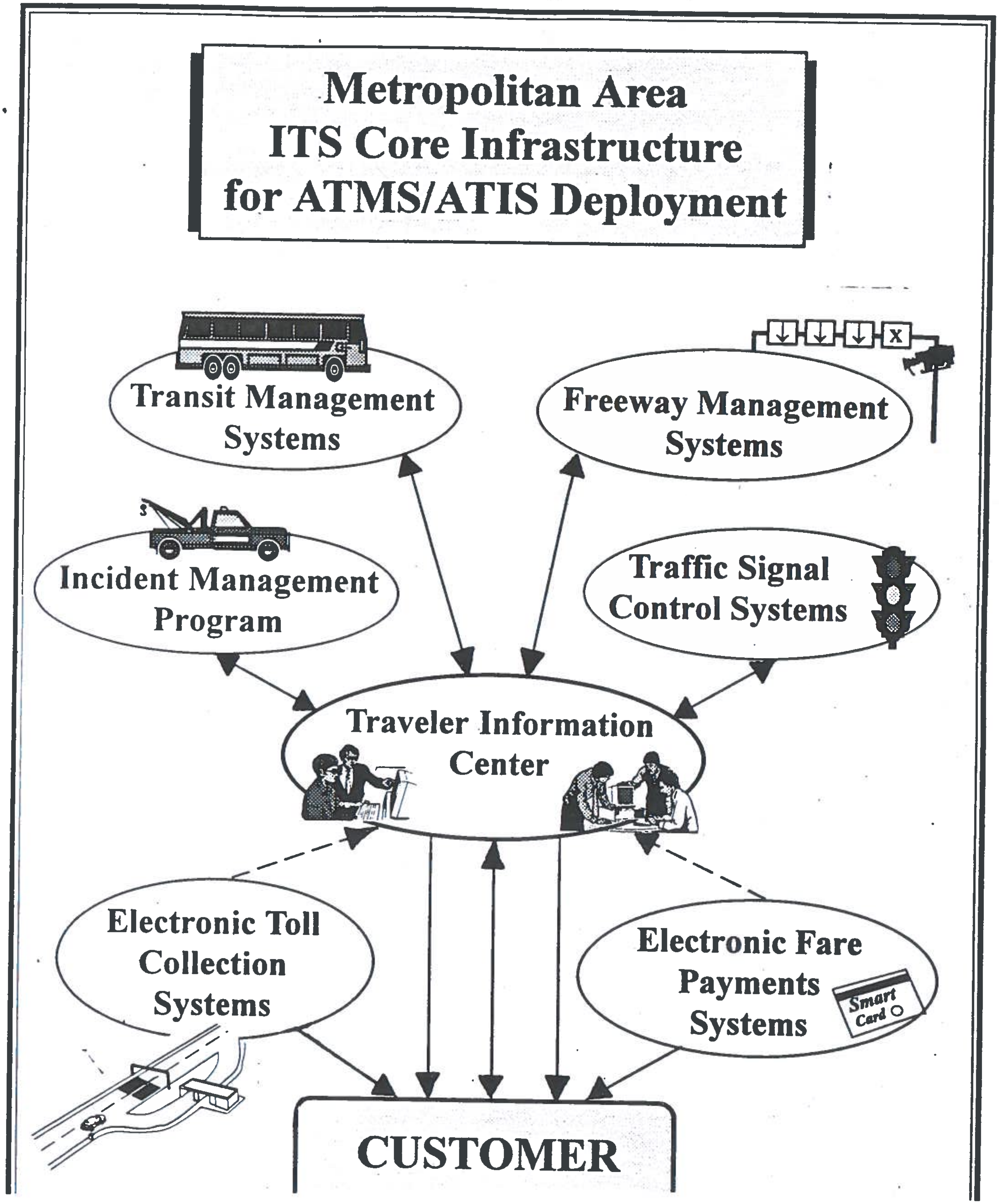
An electronic payment system is in operation within the metropolitan area for transit fares. The system(s) include hardware and software for roadside, in-vehicle, and in-station use; and passenger/driver payment cards, possibly with software, financial and card accounting system(s). Electronic fare collection eliminates the need for customers to provide exact change and facilitates the potential creation of a single fare medium for all public transportation services.

The system(s) could include both debit and credit capability; although stored-value capability is a requirement, and cash would also be accepted. Where appropriate, the system(s) would facilitate the participation of employers in transit benefit programs where employers pay for their employees transit accounts which are debited only for work trips.

7. Electronic Toll Collection System(s)

An electronic payment system is in operation within or around the metropolitan area for toll collection. The system(s) include hardware and software for roadside and in-vehicle use; driver payment cards or tags, possibly with software, financial and card accounting system(s); and a communications system between vehicles and the roadside. Electronic toll collection (ETC) will allow drivers to pay tolls without stopping, thus decreasing delays and improving system productivity.

The system(s) could include any combination of debit, credit or stored value capability. ETC systems could be installed in various configurations, including mainline barrier plazas and systems where tolls are based on entry and exit points. Specific components of the system(s) are expected to include automatic vehicle identification, automatic determination of tolls for differing classes of vehicles, automated enforcement of violations and flexibility in financial arrangement.


Metropolitan Area
ITS Core Infrastructure
for ATMS/ATIS Deployment
Transit Management Systems
Freeway Management Systems
Incident Management Program
Traffic Signal Control Systems
Traveler Information Center
Electronic Toll Collection Systems
Electronic Fare Payments Systems
Smart Card
CUSTOMER

Dial-up information service
Other information distribution means
Areawide traffic info broadcast [e.g. FM subcarrier]
Private sector firms selling traffic info services
Operations / maintenance / management personnel
Other ---

Traffic Signal Control System(s)
Jurisdictions with signal systems
Intersections w/ microprocessor controllers
Signals interconnected with at least one other signal
Signals centrally controlled
Signals under 1st generation control
Signals under 1.5 GC
Signals under 2nd GC
Loop and other electronic detectors
CCTV cameras
CCTV cameras with VIDS
Arterial CMS
Arterial HAR stations
Method and frequency of timing plan updates
Preemption for emergency vehicles
Signal priority system for transit/other vehicles
Operations / maintenance / management personnel
Other ---

Freeway Management System(s)
Jurisdictions with freeway management systems
Total length under electronic surveillance
Total length with lane use control
Metered ramps
Loop and other electronic detectors
CCTV cameras
CCTV cameras with VIDS
CMS
WIM / Inspection Sites
HAR stations
Callboxes
Operations / maintenance / management personnel; facility(ies) description
Coordination / communication with emergency management entities
Other ---

SURVEY OF FEATURES OF METROPOLITAN AREA ATMS/ATIS CORE INFRASTRUCTURE ELEMENTS

Movement toward deployment of the above-defined core elements will occur in an evolutionary fashion, building upon existing metropolitan-area hardware / software / communications systems and institutional relationships. Metropolitan areas should be working toward development of these capabilities, with a special emphasis on laying the foundation for future ITS advancements through selection of open-architecture systems and region-wide institutional cooperation. Time frames and priorities for deployment should be developed based on the specific needs and opportunities in a metropolitan area, and coordinated with the project planning, programming, and development processes underway in the area.

To provide direction and assistance to metropolitan areas engaged in advancing these capabilities, a series of candidate capabilities regarding progress in deploying these core elements can be developed. Each of the above definitions contains statements of "required capability" for the core element, which can be used to generate this type of survey. With appropriate analysis and evaluation expertise, movement towards these capabilities in metropolitan areas can be measured. Through uniformity of this approach, a nationwide view of deployment progress can be developed.

To aid in this survey of core infrastructure deployment, specific measures can be defined to characterize the metropolitan area itself and to gage progress in implementing the core elements. Following are an *initial, draft* set of selected features which could be used for this purpose:

Urban Area Definition
Geographic area
Population: "permanent" and visitors
Air quality / weather indicators
Jurisdictions which operate freeways
Total freeway length
Total freeway length operating at LOS "D" or worse for over 1 hr./day
Total toll facility length
Jurisdictions which operate traffic signals / Number of signals
Transit agencies / Number of buses; rail systems
Other ---

Regional Multimodal Traveler Information Center

Does one exist; single facility or multiple, linked facilities
Jurisdictions/agencies contributing information

Transit Management System(s)
Transit agencies with fleet management systems; facility(ies) description
Buses per transit agency
Buses under fleet management control
Buses with AVL capability
Buses with 2-way voice / data communications
Automated passenger info./electronic schedule systems
On-board displays - visual or aural
Station / bus-stop real-time information
Paratransit / emergency operations applications
Other ---

Incident Management Program
Incident management programs/policies/operations guidelines
Service patrols
Cellular phone # to report incidents
Typical number of incident calls / responses; per year
Accident investigation sites
Average response, verification, and clearance time
Other ---

Electronic Fare Payment System(s)
Transit agencies with electronic payment of fares
Buses equipped with electronic payment systems
Types of payment cards
Other ---

Electronic Toll Collection System(s)
Existing toll authorities / mileage
Toll authorities with ETC
Electronic toll collection coverage
Tags in circulation/subscribers
Other ---

ITS Information and Communications Infrastructure[1]

In the information and electronics age, intelligent transportation services have gradually assumed an important role in improving the operation of the Nation's surface transportation system. Several metropolitan and state transportation agencies are now deploying some form of advance transportation management system. A recent tally of projects assembled by ITS AMERICA showed 12 freeway operation centers, 85 local traffic control centers, 31 freeway service patrols, and 47 incident management programs being established or in operation around the country.

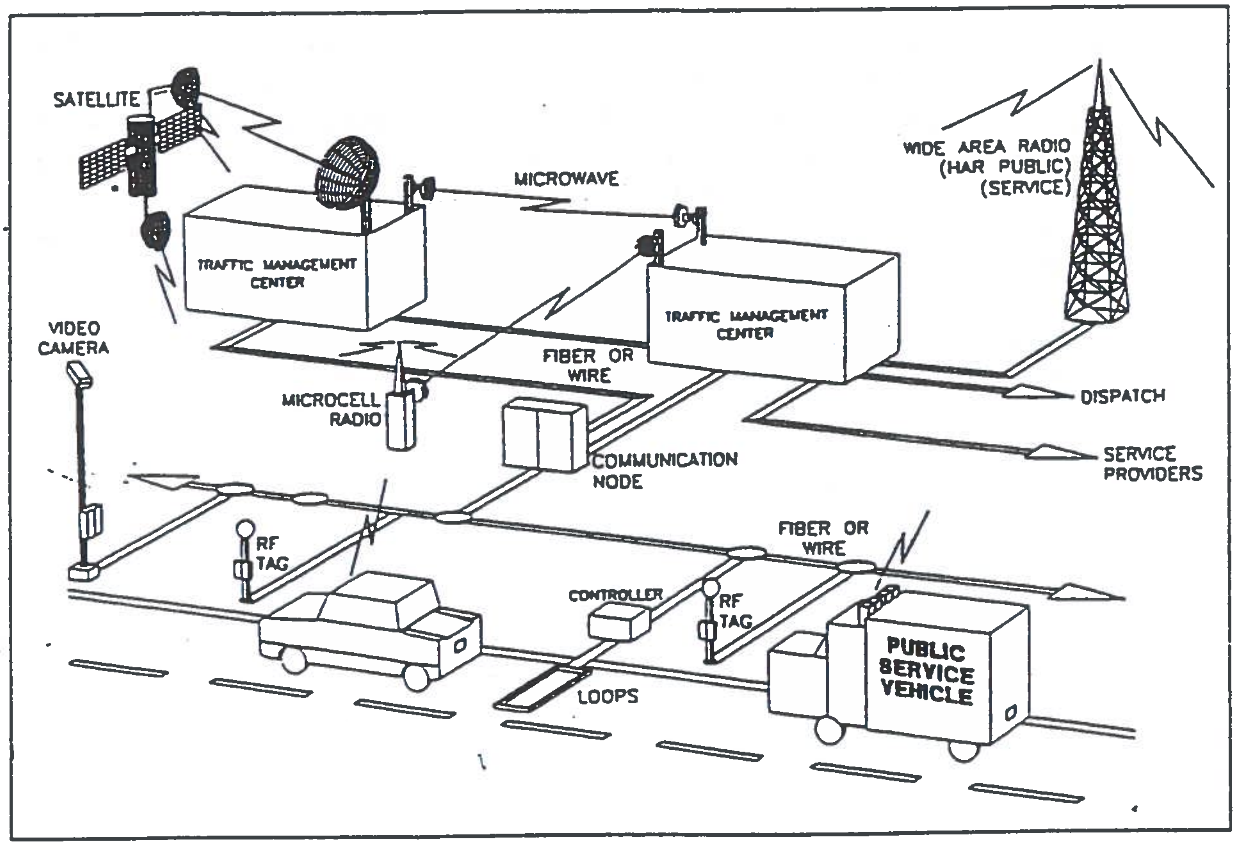
At this time, however, there is no definitive, centralized scheme to deploy ITS throughout the nation. The National ITS Program is at important crossroads; key decisions can be made to stimulate and direct deployment of services now available, and break down barriers to deployment of those services that could become available in a matter of a few years. The need for advanced communication infrastructure is among the most critical barriers impeding ITS deployment.

ITS telecommunications involves information exchange among and between fixed and mobile elements. Mobile elements include vehicles and individuals with PCS, cellular telephones, and pagers. Fixed, or stationary, elements include transportation management centers, roadside equipment (infrastructure), and users with traditional fixed telecommunications systems in the home or office. A variety of telecommunications options exist for mobile and stationary elements, and each option has its own cost and performance trade-offs.

Fixed elements, such as traffic signals and traffic management centers, can communicate over land-lines and via radio or satellite. Cable television and telephone companies have deployed and are continuing to deploy millions of miles of land-lines. A variety of technologies are available for fixed telecommunications including: Synchronous Optical Networks (SONET), Asynchronous Transfer Mode (ATM), Switched Multimegabit Data Services (SMDS), Very Small Aperture Terminals (VSAT), Frame Relay, Integrated Services Digital Network (ISDN), and T1 lines (data rate of 1.544 Megabits per second, Mbps), T3 (44.736 Mbps) lines and lower speed digital and analog services.

Mobile elements, such as vehicles and cellular telephones, can communicate over wireless methods. A variety of technologies either exist or are planned for mobile communications. Possible technologies for one-way mobile communications include Highway Advisory Radio (HAR), FM subcarrier, microwave, and infrared. Two-way mobile technologies include cellular, two-way radio, microwave, infrared, and two-way satellite.

[1] This section contains excerpts from the National ITS Program Plan, First Edition, March 1995.



Source: Kimley-Horn and Associates, Inc.

ITS Telecommunications Technology Selection Criteria

Procuring organizations need to consider several key system attributes when choosing a particular telecommunications technology. ITS telecommunications systems must be cost-efficient, reliable, maintainable, secure, and resistant to obsolescence, as well as interoperable, expandable, and compatible. High reliability is an essential system attribute to prevent losses of critical traffic information, ensure the integrity of electronically-collected toll revenues, prevent serious traffic congestion, and ensure operation of emergency notification functions. To improve reliability, the systems should have continual monitoring, automatic outage detection, and automatic rerouting capabilities. ITS telecommunications systems must be easy to maintain with minimum personnel at a minimum cost. Secure systems are needed to protect the information and to prevent eavesdropping, misuse, service theft, and malicious and inadvertent intrusion. Resistance to obsolescence is necessary because ITS applications will be deployed over several phases. Ideally, near-term hardware, software, and other network components would be compatible with equipment installed during later stages of deployment. ITS telecommunications systems must permit both geographic and vendor interoperability, as well as support for intermodal considerations. They need to operate over a variety of environments nation-wide, ranging from urban population centers to rural areas. The systems must be expandable so that additional capacity and additional user services can be accommodated.

Performance, institutional, and financial issues need to be understood for each specific ITS application when selecting an appropriate telecommunications technology. Key performance parameters include capacity, processing power, reliability, maintainability, operability, range, and speed. Institutional issues include privacy and the openness of architectures and standards. Such issues can affect multi-vendor product availability, compatibility, interoperability, and the ability to accommodate growth and technological advances. Financial evaluations must consider the cost of additional communications infrastructure (if needed) and operations and maintenance costs over the lifetime of the system. The use of existing communications infrastructure can minimize deployment costs.

Public-Private Partnerships

Public-private partnerships can have significant benefits in ITS telecommunications systems. The government can be the catalyst and the facilitator to further encourage private sector involvement in ITS. The capabilities of the private telecommunications infrastructure can be integrated into the ITS telecommunications functions which could foster vendor competition, potentially improve performance, and lower overall costs. One option is a joint public-private partnership sharing of the telecommunications system development. If additional infrastructure were required, a private sector firm could install telecommunications cable and, in exchange for the use of right-of-way, provide the government agency with either reduced cost access to the system or a set number of fiber optic links for the agency's exclusive use. Public-private partnership decisions and the role of private sector incentives need to be made with full knowledge of the impact on ITS communications systems. The availability of right-of-way should be done through a formal solicitation process so that all private sector providers are given equal opportunity to participate.

ITS Telecommunications and the National Information Infrastructure

ITS and National Information Infrastructure (NII) planners can take advantage of their common telecommunications requirements. The ITS America Committees on Telecommunications and Standards and Protocols are coordinating ITS requirements with the NII. The NII, often referred to as the "Information Superhighway," is currently undefined, but it is envisioned as a vast web of communications networks supporting wide and easy access to information exchange and related applications. The NII architecture is being designed to meet societal needs, support market-driven applications, provide maximum interoperability and interconnectivity, permit universal access, and provide user-friendly interfaces. The NII will provide many of the telecommunications functions necessary to support ITS. ITS applications and the NII both require telecommunications links to deliver information to fixed and mobile users. Integrating ITS plans and requirements with NII development will benefit ITS by increasing the compatibility and reducing the redundancy of telecommunications systems. ITS and NII planners should take advantage of the commonality by coordinating their requirements such as the location of trunk lines in relation to highways and the combined bandwidth needs. A thorough examination and usage of the NII infrastructure in a community will reduce costly duplication and unused capacity of existing NII assets. Dedicated ITS telecommunications systems may be needed in addition to the NII, because of certain ITS-specific applications, such as weigh-in-motion (WIM), electronic toll collection (ETC), and collision avoidance. The commonality between ITS and NII will be clarified in a U.S. DOT-sponsored study titled ITS Communications Alternatives Test and Evaluation. The U.S. DOT, with support from ITS America and in conjunction with other U.S. government agencies, will play an influential role in determining NII requirements and, as a result, will take full advantage of the common requirements between ITS and the NII to ensure compatibility and eliminate redundancy.

Telecommunications System Deployment Options

When deploying telecommunications systems for ITS, the deploying public or private organization generally has three options: 1) build and operate a dedicated ITS facility; 2) purchase services and facilities from private sector telecommunications providers; or 3) enter into public/private partnerships with private sector telecommunication providers. Each deployment method has its own advantages and disadvantages. Dedicated systems can provide known capacity, control, and potential long-term cost benefits. However, the risks associated with such systems include high initial investment costs, potential for technology obsolescence, difficulties with interfaces over separate jurisdictions, potential incompatibility between geographic locations and between user services, and costs and complexities of operation and maintenance. A dedicated system might duplicate existing private sector infrastructure and therefore be an unnecessary expense of resources. It might also have excess capacity which could raise costs and may necessitate either adding other applications onto the system or selling the excess capacity. Selling excess capacity or offering additional services to subscribers of a government-owned dedicated communications system places the government in competition with the private sector providers of telecommunications systems and services. This is an issue of fair competition in the market place and what type of role the government should play.

Existing publicly-available, private sector telecommunications systems require less of an initial investment, are continually upgraded with new technologies, and can provide geographic compatibility, user service compatibility, and ease of operation and maintenance. However, the risks associated with using the existing private sector-owned systems include lack of infrastructure availability and capacity along some highways, and high costs due to regulatory policies and lack of competition at the local level.

A third approach is a public/private partnership. Many partnership arrangements are possible. An example is one in which the public sector makes its right-of-way available to the private sector through a formal solicitation process. In general, the public sector may require a specific capacity, such as a specific number of fiber optic strands, be reserved for their dedicated use. In return, the private sector participant would be able to lay land lines along the right-of-way and sell the remaining capacity to their customers. One benefit of this type of arrangement is that telecommunications facilities would be located near the roadway, making it accessible for transportation data collection. In addition, maintenance arrangements could be negotiated between the participants. The availability of right-of-way should be done through a formal solicitation process so that all private sector providers are given equal opportunity to participate.

The optimum deployment method will vary, depending on several factors such as the specific ITS applications, the deployment region, solutions to institutional barriers, and changes in regulatory policies. To determine the optimum deployment method, each procuring organization needs to perform an accurate cost and capability assessment over the life of the telecommunications system, including both initial investment costs as well as on-going maintenance costs and scheduled upgrades. Analysis of the dedicated government-owned system must address the issues associated with excess capacity and duplication of private sector telecommunications systems. Analysis of the existing private sector-owned systems must address the leasing fees and capacity availability. Analysis of a public/private partnership must address capacity, operations and maintenance costs, and the availability of right-of-way. In all approaches, liability issues should also be analyzed.

CONCLUSION

The national ITS architecture and activities that coordinate ITS standards development and ITS telecommunications systems will facilitate national compatibility. The national ITS architecture describes the governing plan and defines the relationships among system components. Standards help achieve national and global compatibility and can positively influence other product attributes such as performance, design, manufacturability, and cost. A coordinated standards development process promotes timely identification and development of needed standards and eliminates redundant standards activities. Telecommunications systems provide information exchange for virtually all of the ITS user services. Many types of telecommunications technologies are available, and they are continually evolving. Technology choices will have to be evaluated according to the specific application, such as fixed or mobile, one-way or two-way, and short range or wide area. The national ITS architecture and coordinated standards development and telecommunications systems are strategic elements that can foster a nationally compatible ITS.

It has been recommended that the U.S. Department of Transportation be more assertive initially in facilitating the deployment of ITS information and communications infrastructure, leveraging off of private sector facilities and services wherever feasible -- a first step could include establishing and stimulating the communications and information infrastructure needed to deliver many of the ITS services.

Communications, Fiber Optic Cable, and ITS

Figure 1 is a schematic of the general flow of communications in ITS. At the center of the diagram are "Independent Service Providers".

There are two types of Independent Service Providers (ISP) in ITS.
Communications providers such as the cellular carriers or local exchange carriers provide the telecommunications services which tie the users to system services. Information service providers such as travel planners, route guidance services, on-line "yellow pages" and on-line travel information services (Prodigy, CompuServe, etc.) act to provide some of the system services offered by ITS. A given entity may fill both roles.

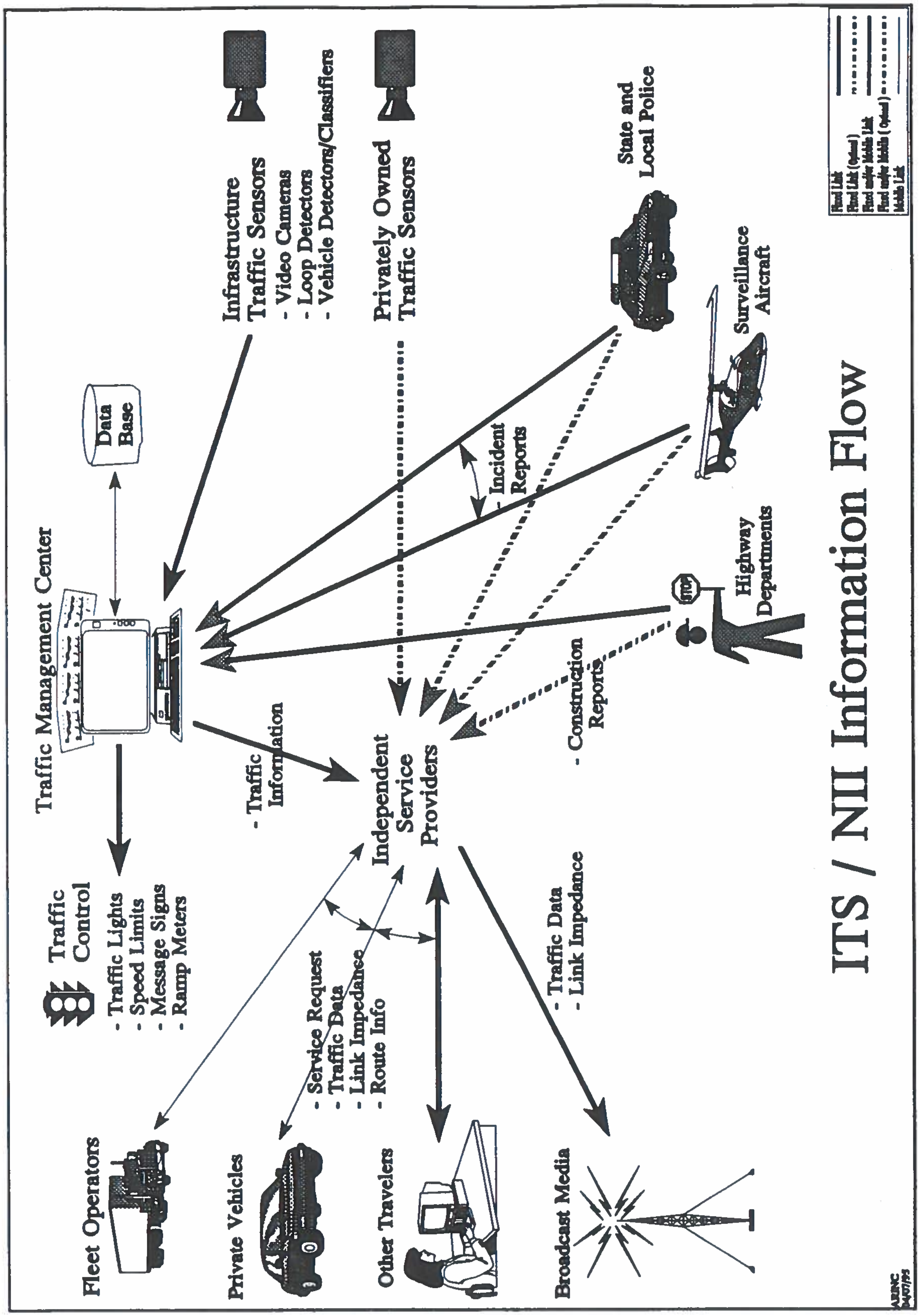
Both types of ISPs are crucial to the success of ITS. The potential market for communications ISPs is estimated at approximately 10^{11} bits per day in an urban market of 3-5 million people (see Table 1). Some of this market is serviced by municipal government; the remainder (and likely the largest share) is to be provided by ISPs.

The services which are more likely to be provided by municipal governments include traffic control, traffic sensors, transit operations, and emergency services. The market for these services is about 10^{10} bits per day; the majority of this is traffic sensors and control.

This raises the issue of whether or not government providers should own and maintain communications facilities which could be provided by private (i.e., commercial) communications providers. There are several factors which encourage government ownership:

- Public safety concerns dictate high availability of the medium.
- The criticality of the information on the channel requires that the government be directly accountable for its delivery. Police and fire communications, and transportation control systems are examples.
- Government ownership may be less expensive or more expedient than purchase of commercial service.

However, government ownership can appear to place local government agencies in competition with commercial communications providers. Fiber optic cable has a high capacity. There is a small marginal cost to lay multiple cable pairs when installing the fiber cable. As a result, municipal agencies may find themselves with a significant amount of unused capacity. Naturally, there is pressure from other government agencies to have access to this capacity; some of these agencies could not justify government facilities because their mission does not reflect the same availability or criticality requirements as other agencies.



ITS / NII Information Flow
Traffic Management Center
Data Base
Traffic Control
- Traffic Lights
- Speed Limits
- Message Signs
- Ramp Meters
Infrastructure Traffic Sensors
- Video Cameras
- Loop Detectors
- Vehicle Detectors/Classifiers
Privately Owned Traffic Sensors
State and Local Police
Surveillance Aircraft
- Incident Reports
Highway Departments
- Construction Reports
- Traffic Information
Independent Service Providers
Fleet Operators
Private Vehicles
Other Travelers
Broadcast Media
- Service Request
- Traffic Data
- Link Impedance
- Route Info
- Traffic Data
- Link Impedance

Table 1. ITS Communications Market - Estimated Daily Traffic

(Urban Region, Population 3-5 Million)

Service Bundle	User Service	Daily Load (in bits)	Potential Provider: Govt	ISP	Veh
Travel & Transportation Management	En-Route Driver Information	5.74e+09		X	
	Route Guidance	2.58e+10		X	
	Traveler Services Information	2.58e+10		X	
	Traffic Control	1.27e+08	X		
	Incident Management	5.53e+07	X		
	Emissions Testing and Mitigation	-	X		
Travel Demand Management	Demand Management and Operations	-	X		
	Pre-Trip Travel Information	3.54e+09		X	
	Ride Matching and Reservation	-		X	
Public Transportation Operations	Public Transportation Management	8.41e+07	X		
	En-Route Transit Information	1.63e+08	X	X	
	Personalized Public Transit	1.62e+08	X		
	Public Travel Security	2.70e+03	X		
Electronic Payment	Electronic Payment Services	9.81e+08	X	X	
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance	1.44e+08		X	
	Automated Roadside Safety Inspection	2.57e+05	X		
	On-board Safety Monitoring	9.89e+09		X	X
	Commercial Vehicle Administrative Processes	9.89e+09		X	
	Hazardous Materials Incident Response	9.89e+09	X		
	Freight Mobility	5.13e+08		X	
Emergency Management	Emergency Notification and Personal Security	1.44e+05		X	
	Emergency Vehicle Management	4.42e+07	X	X	
Advanced Vehicle Control and Safety Systems	Longitudinal Collision Avoidance	-			X
	Lateral Collision Avoidance	-			X
	Intersection Collision Avoidance	-	X		X
	Vision Enhancement for Crash Avoidance	-			X
	Safety Readiness	-			X
	Pre-Crash Restrain Deployment	-			X
	Automated Highway System	-	X		X

There are options for government - commercial partnership which may alleviate commercial provider's concerns about government competition. At the poles of this issue are pure government ownership of fiber on one side, and commercial ownership on the other. A middle ground option might be government ownership of fiber with commercial access to excess capacity. A second option is commercial ownership of the cable, with government access to a negotiated number of fiber pairs in return for use of government-owned right-of-way. A variety of negotiated options are possible. For example, the South Jersey Transportation Authority has recently solicited suggested private-public partnership approaches for installation of fiber along their right-of-way (the Atlantic City Expressway). Table 2 below presents some of the pros and cons of selected options. Ultimately, the balance between governmental responsibilities and market segment economics will determine infrastructure ownership.

Table 2. Fiber Ownership Options

Fiber Ownership Model	Advantages	Disadvantages
Pure government ownership	• Government control provides full & direct accountability • Costs controllable	• Restricts commercial access to public Rights-of-way
Government ownership, excess capacity sold to commercial providers	• Maintains accountability and cost control • Alleviates govt-commercial competition	• Commercial operators dependant on outside agency for maintenance support
Commercial ownership, govt. provided access to fiber pairs in exchange for use of public right-of-way	• Commercial access to right-of-way for plant expansion • Govt saves installation costs	• Accountability for service unclear • Maintenance access for commercial operator may be limited
Pure commercial ownership	• Provides maximum participation of commercial sector in national communications infrastructure	• Removes control and accountability from Govt. • May not service areas needed by Govt.

"A COMMUNICATIONS DEPLOYMENT ALTERNATIVE FOR IVHS" (appeared in THE IVHS REVIEW, Summer 1994)

Authors: Brian Stark and Suzanne Mattenson
Bell Atlantic

When discussing the deployment of IVHS services and technology, typically applications such as electronic tolls, video surveillance, loop detectors and variable messages signs come to mind. What is not widely recognized, however, is that the underlying structure necessary to support the aforementioned applications is communication.

Intelligent Vehicle Highway Systems mandates the use of fiber optic communication media, state-of-the-art electronics and specialized computer technology in order to maximize the efficiency of existing transportation infrastructure. Although IVHS is comprised of a diverse portfolio of components, "communication" is the most critical. Each IVHS sub-component mandates the efficient and effective use of a communications network in order to meet the requirements of collecting, utilizing and disseminating real time traffic information.

Any number of communications alternatives can be deployed in order to accomplish these objectives. However, a solution that meets both the initiatives espoused by the National Information Infrastructure (NII) Initiative and the Department of Transportation (DOT) IVHS Strategic Plan is worthy of further examination. As the Regional Bell Operating Companies (RBOCs) and the Independent Telephone Companies (ITCs) rush to modernize their networks to deploy advanced switching and transmission technologies to support a broad range of information age voice, data and video applications, the synergies between IVHS and the Public Network should not be overlooked.

Key Congressional members, including influential representatives from the Senate Appropriations Committee, have articulated support for this synergy. Understanding that a priority goal of the Clinton administration is the development of a privately owned NII, these members have recognized that existing providers, using primarily fiber optic technology, are now rebuilding the U.S. communications backbone.

Therefore, these members of Congress have requested that the DOTs, in developing their RFP for communications technology in support of IVHS, determine what fiber optic capacity currently exists or is being developed by the private sector. Agencies could then use this data to develop public-private partnerships where the agency trades access to its rights of way for fiber optic development in exchange for reduced cost access to that system. This strategy is consistent with the DOT's IVHS mission statement, which is to "support development of a domestic IVHS industry by maximizing private sector involvement in all aspects of the program."

Also speaking out in support of such initiatives is Vice President Al Gore whose vision details a privately owned National Information Infrastructure. In an article published in the Roll Call Telecommunications Newspaper, Secretary of Commerce Ron Brown states "the private sector is already constructing an information infrastructure far better, and *far more quickly, than any government agency could hope to do.*" *(emphasis added)*

The DOT IVHS Strategic Plan underscores the importance of developing a public and private partnership approach to IVHS. This public/private partnership arrangement has become one of the biggest challenges facing the IVHS community today, i.e., emphasizing the cooperation between federal, state and county governments with the private sector. In order for the IVHS initiative to succeed, a partnership must involve shared risk and reward and a commitment to work together for the long term.

Additionally, the DOT IVHS Strategic Plan states that "as technologies are developed we should not assume that all the transportation services traditionally provided by the public sector must necessarily continue as such. *Many of these services have more in common with communication and information services that in the United States are usually offered by private companies.* " *(emphasis added)*

The need to establish public and private partnerships is supported at the highest levels of government. Commenting on the vision of a 21st century Transportation Infrastructure, Secretary of Transportation Pena remarks that "new financial techniques, *public-private partnerships and fully private facilities will have a prominent place* in future transportation systems." *(emphasis added 3/22/94 Washington Post)*

The Public/Private Partnership concept and the NII initiative clearly emphasize the need for cooperation between the government and the private sector.

With support from the state and federal government, the RBOCs and the ITCs are expediting deployment of their advanced fiber optic telecommunications networks. It is envisioned that this deployment will improve the quality of life in the United States, stimulate the economy, and enhance our competitive position in the global marketplace. Enabling legislation such as Opportunity New Jersey and House Bill 84 in Pennsylvania will allow Bell Atlantic to accelerate their network deployment of fiber optic and digital facilities within their respective jurisdictions. Recognizing fiber optics as the media of choice for transporting IVHS traffic information, there are clear synergies between the emerging telecommunications infrastructure and the transport requirements of the IVHS community.

Issues such as protection from obsolescence, survivability, maintenance and operations, ease of integration and minimum construction are also critical to the successful deployment of state-of-the-art IVHS communications backbones. They are outlined as follows:

Protection against Obsolescence

With daily advances in information and communications technologies, obsolescence becomes a key issue in procuring IVHS networks. Typically, IVHS networks will evolve over a period of years. Hardware, software and other network components deployed now must be compatible with equipment installed to support future applications. With customer owned networks (privately constructed networks), the level of technology will remain–static throughout the life of the network unless additional capital funding is secured to maintain a desired level of functionality. Costs to provide these technological upgrades will most certainly be significant and ongoing.

An example is the still evolving communications standard, SONET (Synchronous Optical Network). SONET capable devices support a wide array of IVHS applications such as:

- Emergency Telephones
- Computer Networks
  - -LANs, WANs, Toll Operated Terminals
- Traffic Data Devices
  - -Loop detectors, ice detectors, variable message signs
- Video

At present, SONET will allow the passing of the information payload, or the data contained within SONET bandwidth (OC-level), regardless of the specific vendor. However, the path overhead or bandwidth associated with status and maintenance information, which rides above the payload, is still proprietary to specific vendors and will only become "open" with the release of Phase II or III of the SONET protocol.

When deploying IVHS communications networks over the course of months or even years, the issue of systems capability will certainly be crucial.

Survivability

In a fully deployed IVHS environment, failure of a communication backbone can result in the following losses: electronic toll revenue, critical traffic information and, in extreme cases, life, due to the failure of emergency notification capabilities. To plan against these losses, an Authority or Agency must duplicate their deployment of facilities resulting in duplication of costs and extended construction time. Even then, the survivability of the communication network is not insured until construction of all parts of the network are completed.

Maintenance and Operation

The ongoing operations and maintenance of any large fiber optic network requires complex communications hardware and software, highly experienced personnel, vast equipment inventories, intricate operational systems and ongoing commitment to training. Industry sources estimate the cost of maintenance and operations alone to be at minimum *10%* of total IVHS expenditures.

Therefore, current deployment strategies are being impacted by the likelihood of expensing considerable funds to maintain and operate very large order of magnitude data networks which, in many cases are replicating portions of an existing Public Switched Network infrastructure.

The cost in real dollars to support a large, highly trained support staff as well as implementing and maintaining an extensive support system is considerable. Currently, Agencies are looking to "out-source" this responsibility which can only add to the complex level of coordination requirements already imposed on limited state management resources.

Ease of Integration

A successful integration of disparate communications systems is essential to the overall deployment of IVHS applications. The interaction between various Authorities and Agencies must be seamless and secure.

As previously stated, the proprietary issues associated with the SONET architecture become significant when viewed from a management perspective. Through the RFP (Request for Proposal) process, Agencies typically bid to procure their communications needs along with the heavy construction requirements, such as road widening and upgrades, for a specific segment of roadway. Unless there is uniformity in the application and procurement of SONET based communication hardware, multiple management systems may have to be expensed, maintained and supported. Since state wide IVHS systems are typically deployed in piece parts, this problematic scenerio can clearly become a harsh reality.

Minimum Construction

A key objective when deploying a network infrastructure on Agency or Authority right of way is to keep congestion causing construction to a minimum. Those who choose to build their own IVHS networks must first construct and then often duplicate facilities along each side of the highway to protect against cuts and outages.

This strategy will serve only to extend completion dates for IVHS communications networks and will most certainly exasperate network management and service restoral concerns due to the increase in the sheer numbers of devices required to support such an architecture.

Recognizing the criticality of the above mentioned issues, a Public Network approach merits close scrutiny. Through the utilization of Public Networks, whose charter mandates the enhancement of technology as it becomes available, Transportation Authorities can avail themselves to state-of-the-art communications capabilities. Therefore, the requirement to expense new equipment, as upgrades become necessary, is eliminated.

The Public Network approach to survivability is based on a network design utilizing SONET architecture. SONET, a recognized open system standard, provides the capability to automatically re-route communications around an outage. This design provides route diversity through automatic switching to alternate and dual serving wire centers which are monitored 24 hours a day, seven days a week.

The RBOCs and the ITCs proactively monitor their public networks to insure that it meets the highest quality performance standards as set forth by the industry. The latest in testing, diagnostic, monitoring and provisioning systems are employed to remotely identify and correct potential problems before they become service affecting. Backbone communications networks which employ this approach can realize significant cost savings in their operation and maintenance budgets. The provisioning and maintenance of large fiber optic networks requires the RBOCs and ITCs to have in place significant resources dedicated to protect their investments.

Since the providers of Public Networks have traditionally carried sensitive data to an expansive community of interest, neither integration nor security is an issue. Entities such as federal, state and local governments as well as large commercial information providers such as financial institutions and brokerage houses have successfully employed the services of the Public Network to carry their traffic.

Through utilization of their internal SONET architecture, RBOCs and ITCs are able to provide a robust network design, requiring construction on only one side of a Right of Way. Survivability is insured through the routing of traffic data into the Public Network.

Additionally, IVHS communications costs can be controlled through a variety of creative processes, such as leveraging right of way, long term contracts and custom tariffs.

IVHS is a multi-faceted initiative with no single correct solution. However, a solution that meets all the objectives of the DOT IVHS Strategic Plan as well as the initiatives of the NII and would result in an accelerated deployment schedule is certainly a solution that merits further examination. Through the utilization of an existing network infrastructure, specifically the Public Network, Transportation Agencies are able to focus on their core competencies--the movement of people and goods. In turn, the RBOCs and the ITCs will be able to focus on theirs--the movement of information.

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, 23219

RAY D. PETHTEL
COMMISSIONER

J. L. BUTNER
STATE TRAFFIC ENGINEER

May 28, 1993

Route: TSU0
Projects: TSU0-96A-1F1, PE-101
TSU0-96A-101, PE-102
Northern Virginia District
Computerized Signal System

Mr. James M. Tumlin
Division Administrator
Federal Highway Administration
P. O. Box 10045
Richmond, Virginia 23240-0045

Attention: Mr. Allen Masuda

Dear Mr. Tumlin:

As you requested, this is a brief description concerning the change from a VDOT owned hardwire communication system to a leased telephone line system in the Northern Virginia District for the above project.

Initially, our consultant proposed a VDOT owned communication system using poles owned by the utility companies in the Northern Virginia area. After meeting and reviewing 100 existing poles in Fairfax County as a sample, they projected to VDOT that it would take approximately five years and $10,000,000 to make the necessary poles in Fairfax County cable ready for a VDOT contractor to install county-wide interconnect cable at a cost of approximately $1,000,000. Thus the total cost would be approximately $11,000,000.

After receiving this data, the Department realized that in order to build a district-wide signal system in the near future at an affordable cost that an alternate communication method would be required.

In a meeting held in Northern Virginia with the utility companies concerning this matter, C&P Telephone Company suggested that they could offer a system similar to the statewide lottery network. This would provide us with a digital data circuit at a reasonable price and also include the maintenance and expandability for 10 years at the following rates:

Mr. James M. Tumlin
Page 2
May 28, 1993

A. Install phone drop to each signal cabinet @ $100.00
701 locations X $100.00 = $70,100.00

B. Monthly rate $55.00 per location for 10 years
701 locations X $55.00 X 120 months = $4,626,600.00

C. In lieu of a monthly billing the telephone companies (C&P and GTE) have offered a one-time up front payment including maintenance
701 locations X $32.62 X 120 months = $2,743,994.00

This one-time payment would result in a savings of $1,882,606.00
($4,626,600.00 - $2,743,994.00 = $1,882,606.00)

The total cost of a leased line system, including installation and maintenance for 10 years ($70,100.00 + $2,743,994.00) would be $2,814,094.00 compared to a VDOT owned system costing $11,000,000.00 which does not include maintenance. We, therefore, request that you approve this project to pay the one-time payment to C&P and GTE telephone companies.

Sincerely,

J. L. Butner

J. L. Butner
State Traffic Engineer

*
Approved - Date 6-15-93
[signature]
For the Division Administrator
Federal Highway Administration

* To be charged against STP funds only.

Changing Nature of Telecommunications Industry

The Changing Nature of the Telecommunications Industry

As the possibilities for a nationwide electronic communications network come into focus, many industries are positioning themselves to provide multimedia telecommunications services. Pivotal business alliances and regulatory policies will be forged over the next few years. New entrants, mergers and alliances have already begun to change the telecommunications landscape.

Sophisticated technological capabilities have exploded the demand for digital communications, and competition among providers is fierce. Utility, phone, cable-TV, gas pipeline companies and thruway authorities are among the many competitors in this rapidly evolving market.

Fiber optic cables have been found to be superior over other wire or cable technologies, and over wireless telecommunications, especially for deployment of video telecommunications. The capacity of fiber optics is extraordinary. A single glass fiber optic strand can carry at least 32,000 conversations at once, compared to only a few conversations that can be carried by conventional twisted-pair copper phone wires.

Vast economies of scale are created for digital electronics, once the expansive network of hardware is in place. As such, private industries that already have this right-of-way are well positioned to own and operate ITS telecommunication infrastructures. Within the local exchange telephone networks, over $225 billion has been invested, and over four million miles of cable have been laid. Power companies have laid an estimated 10,000 miles of fiber-optic cable.

Regulatory Environment

New legislation is needed to deregulate local access providers, thus allowing the regional bell operators entry to the telecommunications market. There is virtual agreement in the telecommunications industry, on Capitol Hill, and in the statehouses, that deregulating local service will have positive ramifications for the entire economy. However, the policy makers have yet to determine exactly how this process should take place.

Right-of-Way/Shared Resources

Much cooperation is needed between the public and private sectors to facilitate deployment of telecommunications systems. A few state transportation departments have already entered contractual lease agreements with phone companies and other local access providers for ITS communications deployment.

The dynamic nature of the telecommunications industry yields a significant number of uncertainties. For instance, many components are involved in the question of whether to purchase the capital intensive infrastructure or engage in a lease agreement for the right-of-way. Deployment requirements, cost effectiveness, expansion capabilities, and reliability issues are some of the factors to be considered in making this decision. Given the variability of these factors, the decision to buy or lease must be made on a case-by-case basis.

Top Of The Week

COVER STORY

Wire Work

Ameritech's broader presence in the telecom market would mean new, better services

By Mary E. Thyfault

CALL IT DEJA VU. On April 3, U.S. Attorney General Janet Reno, antitrust chief Anne Bingaman, AT&T CEO Bob Allen, Ameritech chairman Richard Notebaert, and others unveiled a deal that would speed competition in the local and long-distance communications markets. The plan, if approved by a federal judge, would for the first time permit a regional Bell company spun off from AT&T to compete in the $68 billion long-distance market. In return, Ameritech agrees to open up its protected local phone markets to additional competition.

The last time officials of the Justice Department, AT&T, and Bell telephone companies stood on a stage together, it was the dawn of a new era in communications competition. While not as dramatic as the agreement 13 years ago to break up AT&T, the Justice-Ameritech deal signals even greater long-term changes—and benefits—than those produced by the Bell system breakup. It lays the groundwork, through competition, for rapid advances in networking technology and communication services.

More Players, Lower Costs

That's what has users excited. "Telecommunications is arriving at the stage that the PC was at eight to 10 years ago," says Douglas Fields, VP of telecommunications for United Parcel Service in Atlanta. "It is becoming a fundamental part of our business and our lives. As soon as there is some real competition among the telephone carriers and the cable TV industry, this whole market is going to explode." The deal could lower communications costs, too. Says Roger Martinez, VP of telecommunications at the Chicago Board of Trade: "The more players, the lower the costs will be."

The government's goal is to open the market. "Nothing works better than a healthy dose of competition," Attorney General Reno said at the Ameritech press conference. That has certainly proved true in the long-distance market, where hundreds of companies now compete for customers. It also has helped in the phone equipment market, where a wide variety of telephones, answering devices, and fax machines can now be bought for just about any price.

They're all connected: Attorney General Reno, Justice's Bingaman, Ameritech's Notebaert, and AT&T's Allen (left to right) at press conference discuss implications of the wide-ranging plan.

But the changes at work here are much broader. They include products and services for advanced digital communications, everything from wireless data transfer to video conferencing to interactive multimedia marketing. "The basis on which we compete has to be service," says Tom Morrow, president of Time Warner Communications, a new competitor in the voice and data communications market, "even though we intend to be price competitive."

Already, telecom providers have begun fighting to offer more advanced systems for business. For example, US West

STAN BAROUH

> "Nothing works better than a healthy dose of competition," Attorney General Reno said.

and Bell Atlantic are both pursuing the national network integration market, and each plans to offer a package of services, equipment, and long-term network management.

Teleport Communications Group in New York, which is owned by Tele-Communications Inc. and other cable companies, will use its fiber-optic networks and its owners' cable networks to offer asynchronous transfer mode-based data services starting sometime this summer.

"I think this competition is inevitable, and I'm very encouraged," says Jeff Marshall, managing director for telecommunications at Bear, Stearns and Co. "I've seen some Bell companies and other competitors doing business on a more aggressive schedule than ever before. As they start adding value-oriented services, customers will really benefit."

History points that way. During the decade after the AT&T antitrust settlement, which split off the local Bell companies and opened the long-distance market to fuller competition, long-distance rates dropped 60%. Also, new services were introduced, many of them first rolled out by AT&T's competitors. Sprint, for example, brought out the first virtual private networking service that lets companies provide easy and inexpensive communications links to their smallest locations.

Long-distance carrier WilTel in Tulsa, Okla., which started as a unit of an oil and gas pipeline company and is now part of LDDS Communications Inc. in Jackson, Miss., was the first to introduce a new generation of packet switching known as frame relay. It was almost two years before the Bells followed suit.

Good For Them

"Competition has certainly proved to be beneficial to the user" since the breakup of the Bell system, UPS's Fields argues. Now, he says, "We are all underestimating the great amount of change that is going to occur and the impact it will have on businesses. There's a lot of gold at the end of the rainbow, and a lot of people are going to be involved."

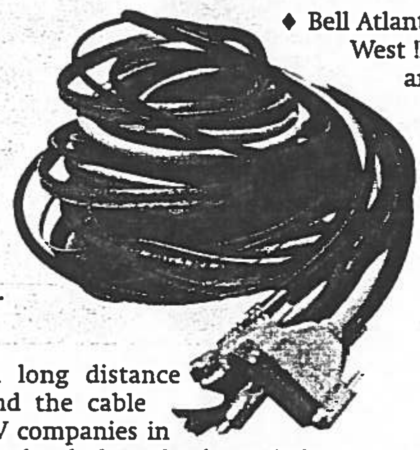
Still, it won't happen overnight. "Nobody has everything right now to compete in what we predict will be a combined $200 billion-plus domestic industry," says Michael Elling, an analyst with Prudential Securities Inc. in New York. "What's going to matter in the end is who partners with whom."

A record $27.8 billion worth of mergers and acquisitions in the information, communications, and entertainment industries were made last year, according to KPMG Peat Marwick. Much of that activity was generated by well-financed companies—either through acquisitions, partnering, or alliance—trying to put in place alternatives to the Bells' local networks. AT&T bought McCaw Cellular, the nation's largest cellular service provider, enabling it to offer a wireless alternative to the Bells' local phone wire. Sprint is

Getting Wired

Companies from every part of the communications industry—local phone companies, long-distance providers, cable TV operators, wireless carriers, and others—are all launching multibillion-dollar campaigns to invade each other's markets. Regardless of who comes out on top, customers should benefit from the increased competition.

- ♦ As of Jan. 1, Rochester, N.Y., began permitting full competition for local phone service.
- ♦ MCI plans to spend $2.5 billion to enter 10 local phone markets by the end of 1995.
- ♦ AT&T is offering local phone service in Rochester, and has plans to offer similar service in Chicago, Grand Rapids, Mich., and elsewhere.
- ♦ Sprint and cable TV partners TCI, Cox, and Comcast plan to spend up to $8.4 billion over the next three years to build an infrastructure for local, long-distance, and wireless services.
- ♦ Four Baby Bells—Bell Atlantic, Nynex, US West, and Pacific Telesis—are teaming up to provide nationwide wireless services.
- ♦ AT&T bought McCaw Cellular for $11.5 billion in 1994 to offer better packages of wireless and long-distance services.
- ♦ US West paid $2.5 billion for a 25% stake in Time Warner, and the two plan to use Time Warner's cable TV systems to invade local phone markets served by other Bell companies.
- ♦ Time Warner offers phone service in 15 cities and has asked for permission to offer residential phone service in Ohio, New York, and California.
- ♦ Ameritech hopes to start a long-distance trial by Jan. 1, 1996. Nynex and Pac Bell have asked for similar authority.
- ♦ BT spent $4.3 billion for a 20% stake in MCI to offer packages of long-distance and international calling.
- ♦ AT&T is working with Singapore Telecom, Kokusai Denshin Denwa, and the European consortium Unisource to provide worldwide service.
- ♦ Sprint is joining France Telecom and Deutsche Telekom to offer global communications.
- ♦ Bell Atlantic Network Integration and US West !NTERPRISE Networking Services are starting to offer packages of equipment and data services nationwide.
- ♦ Teleport Communications Group has just announced plans to offer data services. MFS Communications already offers data services.



partnering with several cable TV companies and plans to spend $8 billion over the next three years to upgrade its networks to provide local voice and data services. MCI, Time Warner Communications, and others are already developing local networks to compete with the Bells. Some cable TV companies on their own are seeking permission from state regulators to enter the local communications business. Other companies are making similar moves (see list above).

Putting It Together

Telecom providers also recognize the need to present a global scope to their services. AT&T is rounding out its international offerings by teaming up with telecom companies in Singapore, Japan, and throughout Europe. BT acquired a 20% stake in MCI. And France Telecom and Deutsche Telekom are each trying to buy a piece of Sprint.

Meanwhile, Congress and state regulators are studying ways to lower regulatory barriers to competition. The Senate is debating legislation that would allow all the Bells to compete in long distance and the cable TV companies in the local phone business. It is illegal in all but 10 states to offer local phone service in competition with the Bells. Regulators in New York, Michigan, and Illinois, which will make a major deregulatory decision April 12, are moving the fastest.

The Ameritech deal is opposed by the six other regional Bell companies, each of which takes in some $10 billion annually in local phone revenue. The other six Bell companies say Ameritech gave up too much by agreeing to open its local network to competitors. But the deal has strong backing from AT&T and other long-distance carriers. "It will eliminate local monopolies," says AT&T's Allen. "Competition means new technology and services at a lower cost to consumers."

Analysts say the changing telecommunications landscape could result in the same confusion and poor service that initially followed the Bell system breakup. "Putting these alliances together is a lot easier on a telecom game board," says Daniel Briere, president of TeleChoice Inc., a consulting firm in Verona, N.J. "Once you start talking about cultures, systems, and personalities, you run into a lot of problems."

Users need to pay special attention to the opportunities—and the potential problems. "Network managers will have to fend for themselves," says Rick Malone, an analyst with Vertical Systems Group, a research firm in Dedham, Mass. Adds Dave Passmore, president of Decisis, a consulting firm in Herndon, Va., "It's going to be harder to tell if you're getting a good deal. It creates a lot more work for the networking staff and requires you to depend a lot more on your negotiating skills."

Still, the benefits to business of increased competition—advanced networking services and products—should outweigh the short-term problems. Ameritech's deal with Justice is a big step in that direction.

The deal, says Ameritech's Notebaert, "dismantles a major roadblock to the information highway."

—with additional reporting by Stephanie Stahl

Special Report

PHONE FRENZY

Is there anyone who doesn't want to be a telecom player?

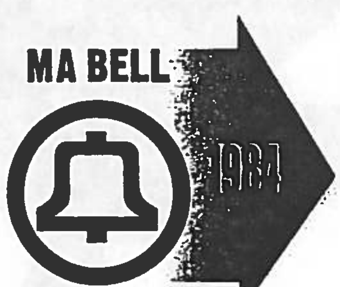
The Area Code Cafe in New York's Greenwich Village may look like just another diner, but it's actually at the forefront of a communications revolution. There's a telephone on every table, and when you order $5 worth of food, you get a token to make a three-minute call to anywhere in the U.S. The restaurant owns the phones and pays a negotiated rate to a long-distance reseller. Owner Joe Marino says the cafe does not make much of a profit, if any, on the service, but the token gesture is popular among students and tourists who like the idea of bundling a meal and a call home into one service.

What's the significance? The Area Code is just one droplet in a flood of players and services pouring into the rapidly deregulating U.S. telecommunications market. Open markets and technologies such as fiber optics and wireless transmission that create huge amounts of low-cost calling capacity mean that just about anyone who wants to become a phone company can. From basement startups to cable-TV operators, energy companies to railroads, literally thousands of outfits are poised to offer phone service. And what happens to your trusty old phone company? Ask Daniel J. Miglio, chairman of Southern New England Telecommunications Co. "There is no future," he says flatly. "They must become something different."

It's the end of the phone company as we know it—part of a massive restructuring of the country's $1 trillion communications industry. Everything from your local phone company to Hollywood studios will be affected. While policymakers rush to keep up, dealmakers, entrepreneurs, and executives are pressing ahead. Mergers, alliances, new entrants, and new services are already changing the telecom landscape.

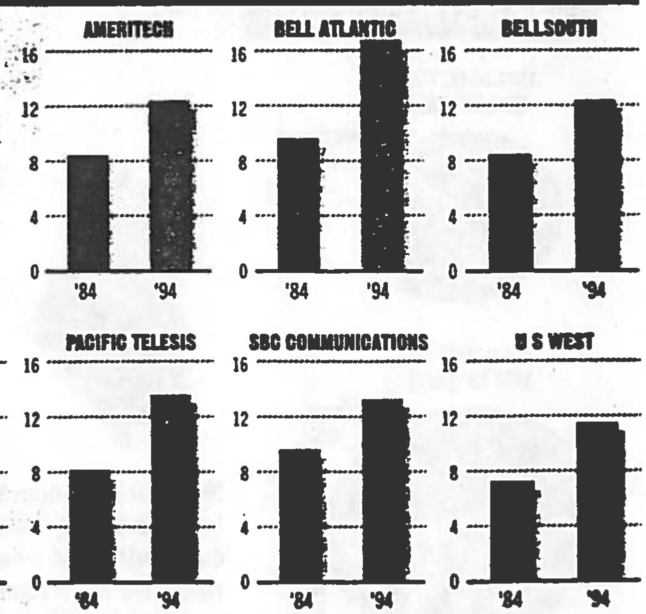
THE EVOLUTION OF THE PHONE NETWORK

The breakup of the Bell System in 1984 started a process of deregulation that, coupled with new technology, is breaking down the barriers between local and long-distance calls. Companies of all types will soon be able to move into both.



LOCAL CALLING (REVENUES IN BILLIONS OF DOLLARS)

The seven regional Bell companies dominate local and intrastate calling. They retain 98% of their markets.



DATA: COMPANY REPORTS, MORGAN STANLEY & CO.

Phone companies want into cable. Cable operators will sell phone service. Long-distance companies will take on local carriers—and vice versa. And everyone will seek "content"—from electronic yellow pages to movies—to lure traffic onto the emerging Information Superhighway.

Who will come out on top? At this point, it's anyone's guess. "By the turn of the century, we'll forget which of the companies were long-distance, local, cable, wireless, etc., because everybody will be offering new services, new sets of services, national brands, local niche products," says Bell Atlantic Corp. Vice-Chairman James G. Cullen. Certainly it will be confusing at first, but a decade of deregulation in long distance has conditioned Americans for what's ahead. After all, until 1984 nobody had ever thought about choosing a long-distance company. Today, 30 million Americans a year switch—jumping among AT&T, Sprint, MCI, and others for the best service and prices.

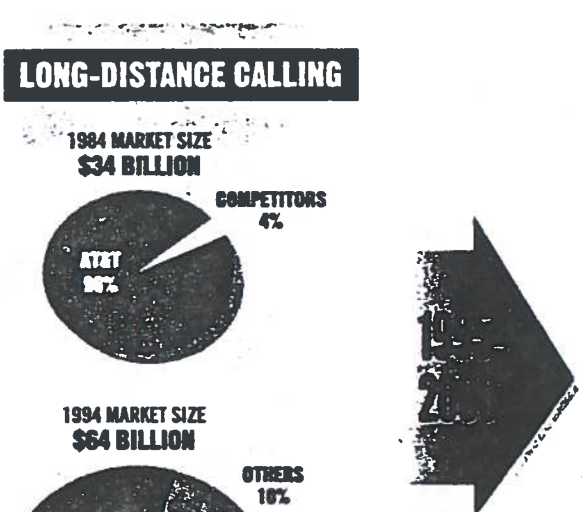
Deregulation and changing technology pave the way for a massive restructuring

"DREAM BUSINESS." The driving force behind today's phone frenzy is technology. Most striking is fiber-optic cable. Conventional twisted-pair copper phone wires carry only a few conversations at a time. But a single glass strand can carry at least 32,000 conversations at once. And by beefing up the electronics, AT&T has been able to transmit as many as 320,000. Continuous improvements in both wired and wireless technologies promise a steep and steady decline in the cost of communications—analogous to the way microprocessors drove down the cost of computers and sparked the personal-computer revolution. Now, new communications technology is bringing forth new ways to deliver a flood of voice, information, and entertainment.

Ordinary phone calls, in fact, will be just one of a half-dozen forms of digitized information that can flow across so-called broadband networks (table, page 95). All this capacity means that a network can handle a virtually unlimited amount of traffic and add new services with almost no new capital investment. "The phone industry is really a dream business. It's the only one where the marginal costs of doing business are zero," says Harry Newton, a New York telecommunications consultant.

Before the legions of would-be telecom titans cash in on that promise, however, there's still one obstacle to remove: a regulatory framework based on the notion of phone service as a "natural" monopoly. That theory made sense when the system was being created. The undertaking was so vast and costly that it was assumed that only one system could be built. Carriers were granted a monopoly but had to provide universal service—low-cost calling available everywhere.

Since the U. S. broke up the Bell System, deregulating the long-distance market but leaving local monopolies intact, the deregulatory movement has circled the globe. "The idea of the natural monopoly has lost all credibility around the world," says Ken Zita, a partner with the consulting firm Network Dynamics Associates Inc. in New York. The most recent example: Germany's decision to accelerate deregulation—because the Deutsche Telekom monopoly isn't deliver-



Now, cable-TV operators, local- and long-distance companies, and a host of newcomers are racing to compete in multimedia communications.

ing the prices and services that German businesses demand.

Now, deregulation is about to hit the last U. S. phone monopolies: the $98 billion local-calling industry dominated by the seven Baby Bells and independents such as GTE Corp.

Special Report

There is virtual agreement in the telecommunications industry, on Capitol Hill, and in the statehouses that deregulating local service will be a boon to the nation. For proof, look at what happened in long distance. Since 1984, carriers have tripped over each other to add new services, and their market-share battles have sliced rates more than 60%. Competition could do the same in local calling, says Senator Larry Pressler (R-S. D.), chairman of the Senate Commerce Committee: "Progress is being stymied by a morass of regulatory barriers that balkanize the telecommunications industry."

Deregulating this massive industry has implications for the entire economy. Americans dialed up some $160 billion worth of domestic calls last year, and analysts estimate that the figure will pass $200 billion by 2000. Lower costs and new services will be a boon to business. And even though many Baby Bells are shedding employees to be more competitive, deregulation should be an overall job creator. An econometric study done by the consultancy WEFA Group Inc.—sponsored by the Baby Bells, mind you—estimates that competition in local calling will spark so much demand for new services that there will be a net gain of 3.6 million jobs by 2003. That's in addition to 1 million phone workers today.

CABLE'S GRASP. When will it all happen? Much depends on Congress. Pressler now leads the effort to replace vintage-1934 regulations. If he can find a compromise between Democrat and Republican approaches, deregulation could begin next year. On the other hand, the legislation could be killed by partisan infighting—as happened last year. Pressler has outlined a bill allowing competitors into local calling immediately but keeping the regional Bell operating companies (RBOCs) out of long distance and cable for one to three years. The Bells want simultaneous entry, while long-distance and cable companies want local carriers shackled until there's measurable local competition.

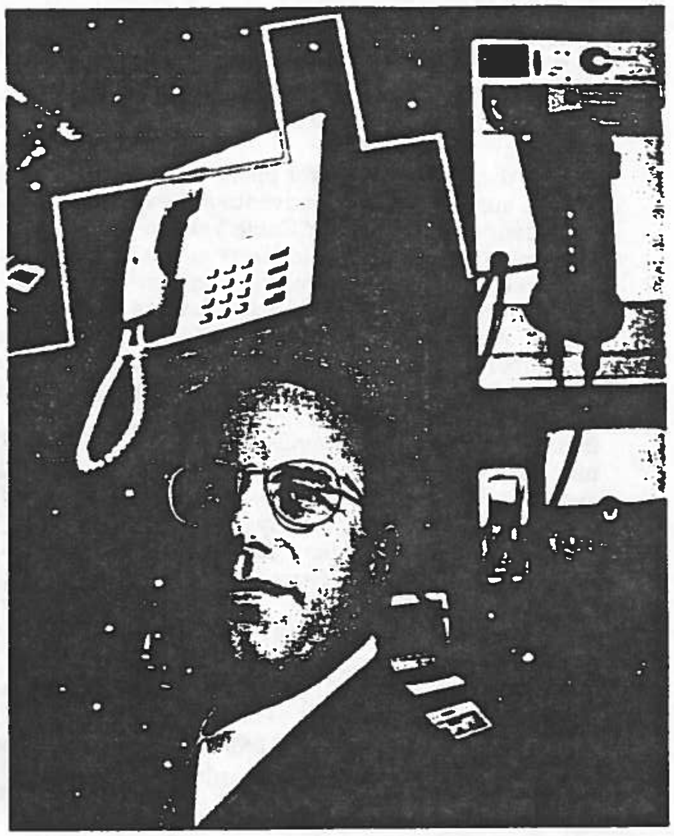
The market isn't waiting. New players are pushing into local service, and at least 10 states already allow some level of competition in local calling. All but three allow competition on some in-state toll calls. On Jan. 1, Rochester, N. Y., became the first U. S. municipality since 1919 to allow full competition in local residential service (page 97). The rest of the state could follow by August.

You might expect Nynex Corp., the regional Bell, to try to block competition, which will take chunks of its market. But the company is cooperating with New York regulators—because deregulation will let the $13.3 billion phone giant leap into all sorts of new businesses such as long distance and cable TV. "I'd rather have 10% of the world than 100% of New England," says President Ivan G. Seidenberg. Nynex took another big step into the competitive era on Jan. 25, when it announced plans to treat MFS Communications Co., a competitive access provider that links business customers to long-distance carriers, as a co-equal common carrier. It's the first such pact between an RBOC and a rival. MFS, a pioneer eight years ago, is about to get plenty of company. Within a few years, consumers may start getting phone bills from cable-TV operators, utilities, or wireless carriers. They could even get service from a totally unexpected type of provider—such as the New York State Thruway Authority. It's gauging the feasibility of laying fiber-optic cable along its rights-of-way and offering phone service.

WIRELESS WONDER GTE has a cordless phone that turns into a cellular phone when you leave the house

It's not so far-fetched. Deregulation brought nearly 500 new entrants into long distance. Wiltel Communications Systems, now part of LDDS, the No. 4 long-distance company, got its start by running fiber along the Williams Cos. gas pipelines. Anyone with a right-of-way could do the same. In Britain, 12 electric companies created Energis, a 2,000-mile fiber-optic phone system. New Jersey's Public Service Electric & Gas Co. is developing a system with AT&T to read meters and offer appliance management, home security, and medical alert services. New Orleans-based utility Entergy Corp. is testing a similar network in Chenal Valley, Ark. These systems could just as easily double as phone lines.

While some players putter, cable-TV operators are plunging in. They own wires that reach the homes of 59 million Americans, and phone service looks like a no-lose situation. Time Warner Inc. executives are expecting an extra $10 per customer each month, and Morgan Stanley & Co. calculates that phone services should add 8% to 10% to a cable system's value. Also, coaxial wiring can handle broadband speeds right away, so it will be cheaper for cable com-



COMPETITIVE FERVOR "I'd rather have 10% of the world than 100% of New England"

— NYNEX PRESIDENT IVAN G. SEIDENBERG

Even the New York State Thruway Authority is weighing the idea of laying fiber-optic cable along its rights-of-way

panies to add voice than for phone companies to add video. "It's a huge competitive advantage," says Glenn A. Britt, president of Time Warner Cable Ventures.

Some of the nation's top cable-TV operators—Tele-Communications, Cox Enterprises, and Comcast—have formed an alliance with Sprint to build and operate a nationwide wireless phone network. The group is the top bidder for licenses to operate a new form of wireless phoning known as personal communications services (PCS), betting $1.4 billion so far that the new technology can fill gaps in a national network. Regulations permitting, the group will offer one-stop shopping for local calling, long distance, cellular, PCS, and cable, says Sprint Long-Distance President Ronald T. LeMay. "We have the chance to offer something that's not in the market right now," says LeMay.

INTERACTIVITY
An AT&T gizmo can transform your TV into an answering machine/banking/shopping terminal

Time Warner Cable already offers bypass services in 15 cities and has applied to offer residential service across New York and Ohio. California regulators say they'll let cable operators offer telephony as soon as any phone company in the state receives approval to offer TV.

The confusing blur between cable and phone operators is intentional: Executives in both industries say their futures may depend on it. "We're going to be an integrated communications company with telephony, video—which is our core—and new products: interactive audio and video products," says William T. Schleyer, executive vice-president of Boston-based Continental Cablevision Inc. "If you don't make the move, you'll have trouble competing in the future. If all you do is play defense, you have no defense."

DEALMAKING. You don't have to tell the Bells. U S West Inc. is furiously repositioning itself for video, paying $2.5 billion for 25.51% of Time Warner and launching video-on-demand trials. U S West, Bell Atlantic, BellSouth, Ameritech, and Nynex have all won federal court rulings allowing them to provide video over phone lines, also known as video dial tone. On Jan. 29, a federal court gave the same right to most of the nation's small phone companies.

The next phase of the wireless boom is another Bell challenge. Most RBOCs have profited handsomely from their cellular holdings, as the industry has streaked to its current $12 billion level. But PCS will bring dozens of rivals. The FCC auctions have attracted hundreds of bidders, ranging from the Baby Bells to one-person startups to cellular tycoon Craig O. McCaw, who has bid more than $300 million for licenses in New York.

Why the scramble? PCS, using higher frequencies and smaller "cells" than cellular, holds out the promise of low-cost phones for use around a town or building—a possible rival to the wired local phones. A study by BIS Strategic Decisions projects that some 77 million U. S. subscribers would consider using a wireless service to replace or upgrade their existing home phone if it were the same price.

In addition to attracting new players, phone frenzy is inspiring a swirl of joint ventures and acquisitions. Worldwide mergers and deals among communications, information, and entertainment companies hit a record $27.8 billion last year, according to KPMG Peat Marwick. "If the phone companies want to stay profitable they'll have to offer multiple services," says Jeffrey Miller, a telecommunications specialist with Andersen Consulting. "But that's going to require a big investment, and they don't necessarily have to carry the whole weight on their own."

"TELECOMPUTER" COMPANIES. Deals now cross every industry line. Pacific Telesis, Bell Atlantic, and Nynex have formed a joint venture with Hollywood superagents Creative Artists Agency to develop new multimedia programming, while Ameritech, BellSouth, and SBC have joined up with Walt Disney for the same purpose. "We've got to make sure we have access to programming," says Ameritech Corp. Chief Executive Richard C. Notebaert. That's why Nynex has invested $1.2 billion in Viacom, while SBC Communications Inc. (formerly Southwestern Bell) has paid $650 million for the Hauser Communications cable system in Maryland and U S West has teamed with Time Warner. "Entertainment and information, we believe, is the wave of the future," says U S West Vice-President for Strategy Development Chuck M. Lamar.

The biggest spender is AT&T. In addition to its $12.7 billion

SAY THAT AGAIN?

ACCESS LINE The circuit that connects a customer to the telephone network.

BANDWIDTH The range of frequencies that can be transmitted. The greater the bandwidth, the greater the capacity.

BROADBAND A fuzzy term describing high-bandwidth connections—generally those that can carry numerous voice, data, and video channels simultaneously.

COMPETITIVE ACCESS PROVIDER (CAP) An alternative to the local phone company.

COMMON CARRIER A company offering telecommunications to the public on a nondiscriminatory basis.

INTERACTIVE Refers to the ability to carry two-way transmissions. Phones are interactive. Cable TV is not—yet.

MULTIMEDIA NETWORK A system that can carry several forms of communications, among them voice, data, and video.

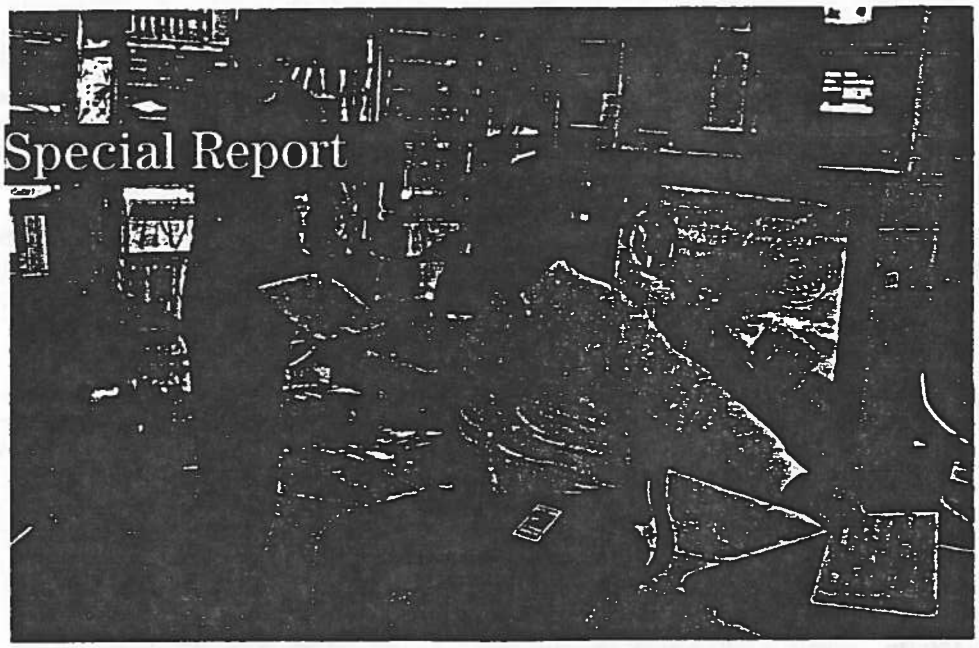
NUMBER PORTABILITY Lets a customer retain the same number when changing carriers.

PERSONAL COMMUNICATION SERVICE (PCS) A digital wireless service that might be inexpensive enough for full-time local calling.

RESELLER A company that buys transmission services at bulk rates for resale to the public for a profit.

SPECIALIZED MOBILE RADIO (SMR) A two-way, radio-dispatch service being upgraded to provide cellular-like phone services.

VIDEO DIAL TONE An automatic connection to a network transmitting video.



REINVENTION

Bell Atlantic is racing to develop multimedia systems, as well as programming

purchase of McCaw Cellular Communications, it has bought into a string of technology startups, including game makers 3DO and Spectrum Holobyte and software publisher Knowledge Adventure. It's one of the big backers of General Magic Inc., which provides the software for the phone giant's new PersonaLink messaging system. "We've come to the gradual realization that we can't afford to do everything ourselves," says AT&T Chairman Robert E. Allen.

Computer giant IBM doesn't want to be left out, either. It flirted with telecom in the 1980s and got burned. But with communications and computing merging, it can't afford to sit this one out. IBM already operates the world's largest data network and resells voice services to some customers. John M. Whiteside, general manager of IBM's Global Network, says the company won't compete with voice carriers but will sell customers services to conduct electronic commerce. As he puts it: "It's the birth of the telecomputer company."

FIBER GLUT. What will all this bring to consumers? For a glimpse, visit Bell Atlantic's $200 million so-called "digital factory" in Reston, Va. There, the company is devising a system to deliver movies on demand, home shopping and banking, interactive programming, and information services to TVs over copper phone lines—all without interfering with regular calling. Up at AT&T in New Jersey, engineers have a gadget to turn your TV into an answering machine/home-banking/interactive-shopping terminal. GTE Corp. has a cordless phone that turns into a cellular phone when you leave the house. BellSouth Corp. is pushing personal digital assistants that send and receive E-mail, faxes, and voice calls wirelessly.

The new telecom world won't just be big companies with whizbang techno-goodies. A glut of fiber capacity has created a bonanza for entrepreneurs. Anyone who can make a deal with MCI Communications Corp. or AT&T to buy capacity at bulk rates can become a reseller. Former dental hygienist Kathy Haycock, 43, mortgaged her home to start Call-America, an AT&T reseller, in Mesa, Ariz.. "No one would give me a loan because they thought it was crazy," she says. Now, she has 25 employees and 20,000 customers. Deregulation should bring reselling to local calling, too. In fact, in Rochester, rivals will start by leasing Rochester Telephone Corp. capacity.

Long-distance companies are itching to get into local service—and pay lower fees to the Baby Bells

The specter of hundreds of competitors where once there were none has energized the Baby Bells to turn efficient—fast. Until the past year or two, they had little incentive to cut costs. Most states capped rates at a predetermined profit level, and about half still do. Nynex, the most tightly regulated Bell, is allowed a rate of return on assets in New York of only 9.15%—anything more is returned to customers in the form of rate cuts.

Now local phone companies have plenty of motivation. In addition to competition for local calling, they could face a sharp reduction in their most lucrative business: the access fees they collect from long-distance carriers. Those fees totaled $30.8 billion in 1994, some 30% of the RBOCs' total revenue—and more than 40% of the long-distance carriers' expenses.

Deregulation will change that. The Bells expect to get into long distance, but long-distance carriers also expect to get into local service—in part to slash access fees. Each of the big three of long distance is preparing direct local connections—Sprint through its cable consortium, AT&T through McCaw, and MCI through a bypass network planned to reach businesses in 200 cities within five years. It will be worth the $2 billion cost, says MCI President Gerald H. Taylor. "Cut access, cut access, cut access, that's what it's all about." AT&T Executive Vice-President Alex J. Mandl says the phone giant will try any form of local access—wireless, cable, building its own local loops, even reselling Bell service. "We must have as many links to the customer as possible," he says.

Can the Baby Bells thrive amid all this competition? Or will they be mere victims? "It's a wake-up call," says SBC Executive Vice-President James R. Adams, who has glimpsed his future in Britain. There, SBC is part of a cable-TV joint venture in which 60% of the 1.3 million subscribers use the cable system for local phone calls. The way he sees it, SBC's cable unit "is the hunter, and we're the hunted.... We just have to make sure we're not the easiest deer for our rivals to find."

All the local phone companies are furiously trying to look less like prey. They're spending billions to create stronger brand names and build broadband networks. Pacific Telesis plans to spend $16 billion over seven years; Bell Atlantic has budgeted $11 billion; U S West $10 billion; Southern New England Telecommunications $4.4 billion.

The Bells are also investing in new management talent. Two years ago, Ameritech hired 40-year-old James Firestone away from American Express Co.'s Travelers Check Group to run its residential business. A quarter of Nynex' executive staff has been hired from outside the phone business—mainly to boost marketing. It's an important step toward the day when customers will have a local service choice, says Seidenberg. "Our obligation to our customers is to get on with the change."

Such sentiments are becoming the norm rather than the exception among Bell execs. And why not? Despite the risks, deregulation has been, above all, a boon to phone companies. The International Telecommunication Union notes that in every market where competition has been introduced, rates have fallen and calling volumes have risen dramatically. Just consider AT&T: It has lost 40% of its market share and dropped rates by 60% over the past decade—and it's doing better than ever. Revenues for 1994 jumped 8.3%, to $75.09 billion, equal to its predivestiture level, while operating profits soared 26%, to $4.71 billion. "The people who are worried about their slice of the pie today are goofy. They should be worried about expanding the pie," says Southwestern Bell Mobile Systems Chief Executive John T. Stupka. If they're not convinced, they should stop by the Area Code Cafe for a token.

By Catherine Arnst in New York, with Kevin Kelly in Chicago, Peter Burrows in Dallas, and bureau reports

THE NEW ERA BEGINS IN ROCHESTER

Competition in local phone service is more than just a dream in Rochester, N.Y. On Jan. 1, it became the first U.S. city in 75 years to allow residents a choice of local carriers. Rochester Telephone Corp. lets any and all comers connect to its network and its customers. The reward: an end to Rochester Tel's state-mandated profit limits and the right for it to offer long-distance and video services. The agreement makes this Great Lakes community of 750,000 a test bed for the telecommunications battle to come.

Granted, the change is not much in evidence yet. Time Warner Inc., the local cable company, has set up booths in malls around town to push a new cellular service, and AT&T is carrying out a direct-mail campaign to sign up customers for local calling. Other potential competitors are eyeing the market. But consumers aren't dashing out to change carriers. "I'm not really sure what's going on yet," says Valerie Huff, a high school math teacher. "Nobody's really talking about it."

TELECOM BAZAAR

Time Warner is selling cellular service and upgrading its cable network for telephony

ESCAPEE. Why Rochester? Mainly because Rochester Tel is not a Bell. Founded in 1899, it managed to avoid joining the vast Bell system and so escaped the many restrictions placed on the regional operating companies when AT&T was broken up. As a result, Rochester Tel—now reorganized as the local service arm of the Frontier Corp. holding company—has always been able to offer long distance outside its service region. It is the seventh-largest long-distance carrier and owns 34 other local phone companies in 13 states, making it the 12th largest local-phone company.

But it was still restricted from earning more than an 11% rate of return by the New York Public Service Commission. So Rochester Tel proposed ending its monopoly in return for an end to profit caps and freedom to compete. It agreed to cut rates 11% and freeze basic residential fees for seven years. Customers can keep their phone numbers if they switch carriers, and competitors must be allowed to connect seamlessly to the local network. Frontier Chairman Ronald L. Bittner says he's delighted. "We figured the worst form of competition is regulated competition," he says. "Besides, we had an ulterior motive. We figured the market would expand and we'd get a larger share, including other carriers paying to use our network."

It does look like a win-win situation initially. Until their networks are built, competitors will simply resell Rochester Tel service. That bothers AT&T. "It's a bad model because the customer doesn't really have any [network] choice," complains Joseph Nacchio, head of AT&T's consumer calling business. Rochester Tel, he says, is charging resellers 95% of its retail price, giving little room to offer cut-rate prices and still make a profit. "It's an interesting experiment, but naive," he says. Still, an AT&T spokeswoman says the company so far is doing "better than expected" in its first month back in the local phone market.

NO MAGIC WAND. Rochester Tel admits its model isn't perfect. "I empathize with AT&T's position," says Jeremiah T. Carr, president of Rochester Telephone. "You can't just wave a wand and have the local monopoly go away.... I can't deny that customers won't think of us first."

Time Warner is determined to make Rochester more than an experiment. It has some 200,000 cable customers there and is upgrading its network for telephony. "We'll have dial tone by the third quarter sometime," promises Glenn A. Britt, president of Time Warner Cable Ventures. Then, the competition will really begin. Is Rochester Tel a little worried? Well, allows the silver-haired Bittner, "I used to have dark hair."

By Catherine Arnst in Rochester, with Michael Oneal in New York

GRABBING A LANE ON THE INFORMATION SUPERHIGHWAY

by Peter Jaret

THE STORY IN BRIEF   Players from the telecommunications, cable, and even entertainment industries are scrambling for position as the possibilities for a nationwide electronic communications network come more sharply into focus. The information superhighway, as this network has been termed, would allow connections and two-way information exchange between virtually all the households and businesses in the country. Tying into such a system would open up a number of new services for electric utilities, from providing electronic meter reading, billing, and payment to offering customers increased control over their own energy use patterns. But EPRI believes that utilities should consider a more aggressive involvement in the information revolution, adding fiber-optic cable to their already far-reaching power delivery infrastructure and partnering with other investors to take an ownership role in the systems now being developed. The results of a new EPRI study provide an in-depth analysis of the business opportunities and risks associated with different levels of involvement in the National Information Infrastructure and provide an analytical framework utilities can use in planning their own strategies.

Forty years ago, the completion of the nation's interstate highway system transformed daily life and commerce in the United States, offering unprecedented mobility and speeding the movement of goods across the country. Today, the construction of a radically different sort of highway is under way—an information superhighway that, like the interstate highway system, promises to profoundly alter the way we live and work.

The revolution wrought by new forms of communication and information storage is hardly new, of course. The real difference now is that a myriad of computer and communications technologies are coming together—linked by high-capacity coaxial cable, fiber optics, and wireless transmission systems—to create a vast information infrastructure. This network of networks, as it has been called, will link homes, commercial centers, and industries across the nation with voice, data, and video telecommunications. "What we're seeing is a marriage of electricity and information, brought about by sweeping technological, regulatory, and competitive changes," says Marina Mann, EPRI's director for advanced information technology.

Largely because of regulatory constraints, the electric power industry has tended to take a backseat to more-visible players like the telecommunications and cable television companies in the high-stakes struggle to determine who will control the resulting network. No longer. Today, utilities are beginning to move aggressively to contribute their assets to the development of the National Information Infrastructure (NII), as the superhighway is officially called—and to exploit their own competitive opportunities.

In response, EPRI recently assembled a team of experts on information infrastructure technologies, financial and business issues, and public and regulatory policy to assess the business opportunities and risks for electric utilities vis-à-vis the emerging information infrastructure. "Electric power utilities have the potential to become significant players, offering not only commercial energy information services but nonenergy value-added services and even telecommunications services in local markets," says Mann, who directed the intensive five-month effort. With sponsorship from both the Edison Electric Institute and the U.S. Department of Energy, the study identified a variety of new markets and new competitive opportunities available to utilities. The EPRI team also explored potential strategic alliances of utilities with other utilities as well as with cable television companies, telecommunications companies, and others.

According to Mann, the window of opportunity for developing a strategic plan may be narrow. "The changing markets for communications and information will play out over the next decade or more, but the pivotal business alliances and regulatory policies that will determine the competitive environment for both the telecommunications and power industries are likely to be forged in the next few years. Certainly within the next three years the most important alliances will be formed and the regulatory framework set," she predicts.

What role will utilities play? What are the competitive risks and opportunities? How can utilities position themselves now to secure a fast lane on the information superhighway?

Electric utilities as key players

A year ago, in a speech before the Academy of Television Arts and Sciences, Vice President Al Gore underscored the importance of electric utilities when he announced the administration's willingness to support regulatory changes that will spur competition and speed the development of the NII. "To take one example of what competition means," Gore said, "cable companies, long-distance companies, and electric utilities must be free to offer two-way communications and local telephone service."

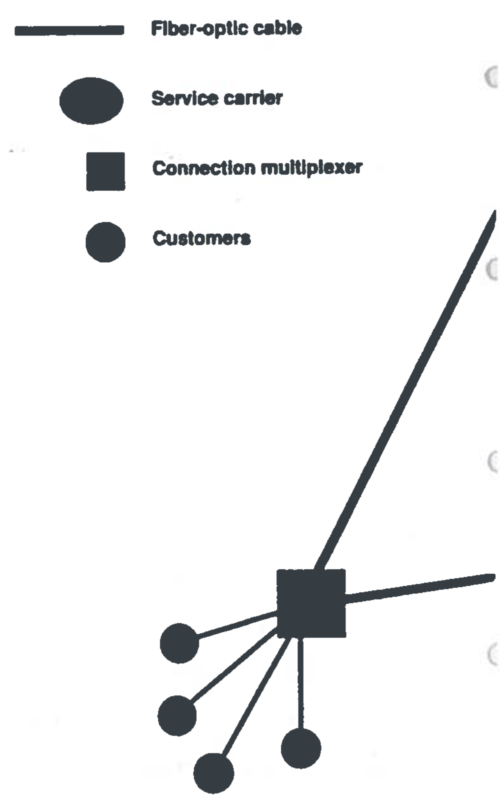
To many in the information and telecommunications industries, the possibility that electric companies will be key players may have come as a surprise. But in fact, EPRI and other industry groups have been working closely with the Cross-Industry Working Team, the White House National Economic Council, and the U.S. Council on Competitiveness to address our country's competitive issues and to provide the technical support necessary to ensure that electric utilities are not precluded from new market opportunities.

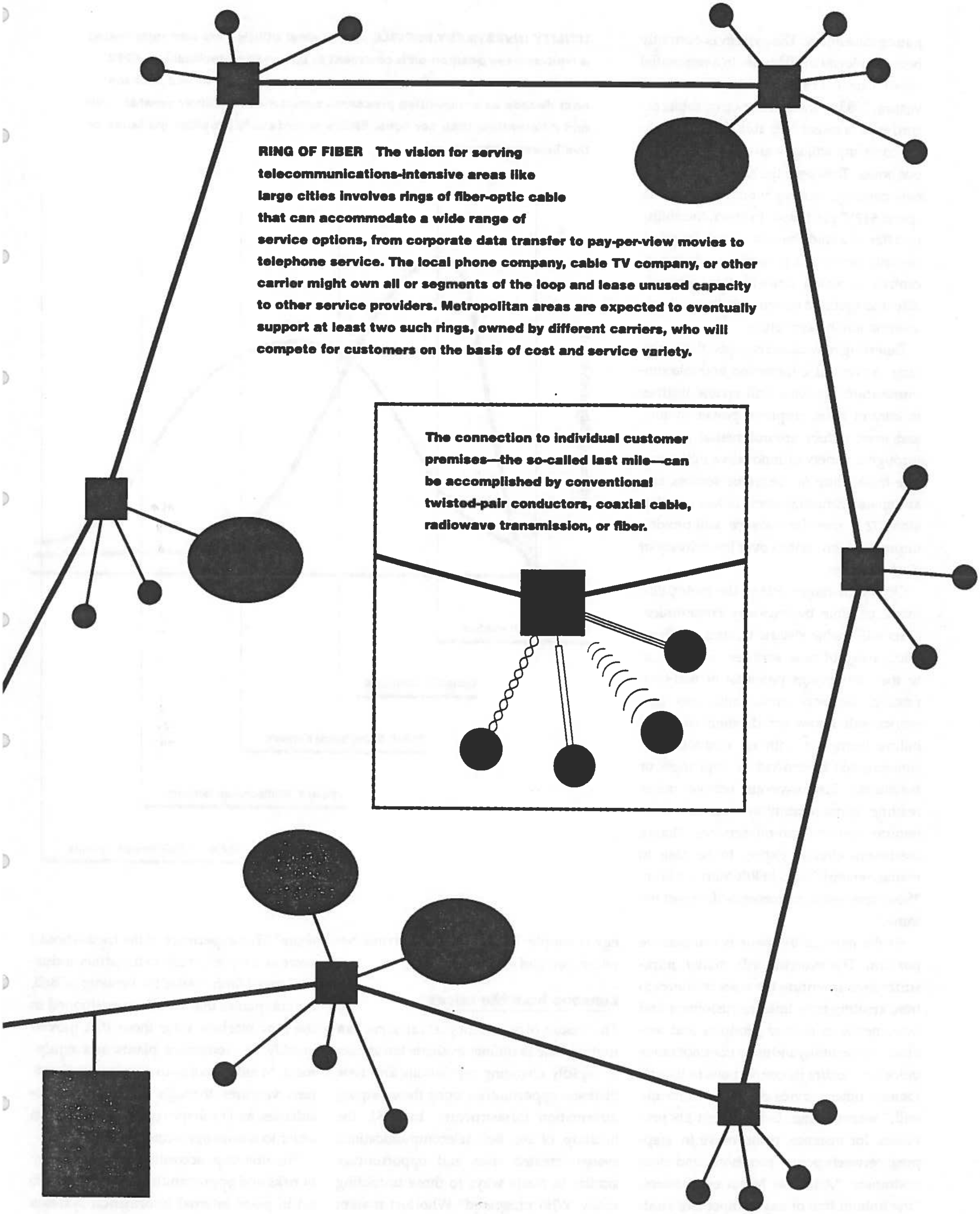
With good reason. "Utilities already have a very strong position in both information and communications, as well as significant assets in terms of rights-of-way, customer-billing systems, and a reputation for reliability," says EPRI's Ron Skelton, who managed the NII assessment study. Electric companies provide service to over 94 million residences; 12 million commercial establishments; and over 500,000 industrial establishments, including 82,000 public schools and 80,000 hospitals and health care facilities. The electric utility industry as a whole is the second-largest owner and user of telecommunications facilities in the country. It spends an estimated $2 billion to $5 billion a year to develop and maintain these facilities. "This is a large sum," adds Skelton, "but since it is a very small percentage of the revenues of the utility industry, it is usual for utilities to treat such investments as operational expenses rather than as a strategic necessity. The study we have just completed suggests that information technology and telecommunications strategy should both influence and support the utilities' strategic business objectives."

Moreover, a growing number of utilities already maintain significant fiber-optic networks. Although no firm numbers exist, estimates suggest that power companies nationwide have laid some 10,000 miles of fiber-optic cable. In a recent article in *Forbes*, Euel Wade, senior vice president at Southern Company Services, called fiber-optic links to customers "the bread and butter [for utilities] to remain competitive." The reason is simple. A 40-strand cable can carry 1.3 million phone conversations or 1920 TV channels simultaneously. Unlike traditional copper phone lines, fiber-optic cables are not affected by electric fields from transmission and distribution systems. Advanced transmission and distribution technologies and information networks are already enabling utilities to move electrons more intelligently.

In fact, of all the major players in the information and telecommunications field, utilities may have the most compelling economic incentive to assume the significant risks of building customer links to the information superhighway. Of the significant players, utilities have the largest plant investment—roughly $6000 per customer, compared with $1200 for local telephone companies and only $800 per line for cable companies. If utilities can reduce load demand through the use of supply-side efficiencies and demand-side management programs based on two-way energy information systems (EISs)—and thus defer the construction of new capacity—the savings could help significantly in offsetting the cost of providing customers with fiber-optic links to the information highway. A recent study by the Southern Company and DRI/McGraw-Hill estimates that accelerating the availability of such systems to allow customers to more closely manage their energy consumption and costs could save customers $78 billion over the next 15 years.

A landmark pilot program being sponsored by Entergy offers an example. Called PowerView, the program uses a real-time, fiber-optic network to provide interactive, two-way communications and price signaling between the host utility and partici-





RING OF FIBER The vision for serving telecommunications-intensive areas like large cities involves rings of fiber-optic cable that can accommodate a wide range of service options, from corporate data transfer to pay-per-view movies to telephone service. The local phone company, cable TV company, or other carrier might own all or segments of the loop and lease unused capacity to other service providers. Metropolitan areas are expected to eventually support at least two such rings, owned by different carriers, who will compete for customers on the basis of cost and service variety.

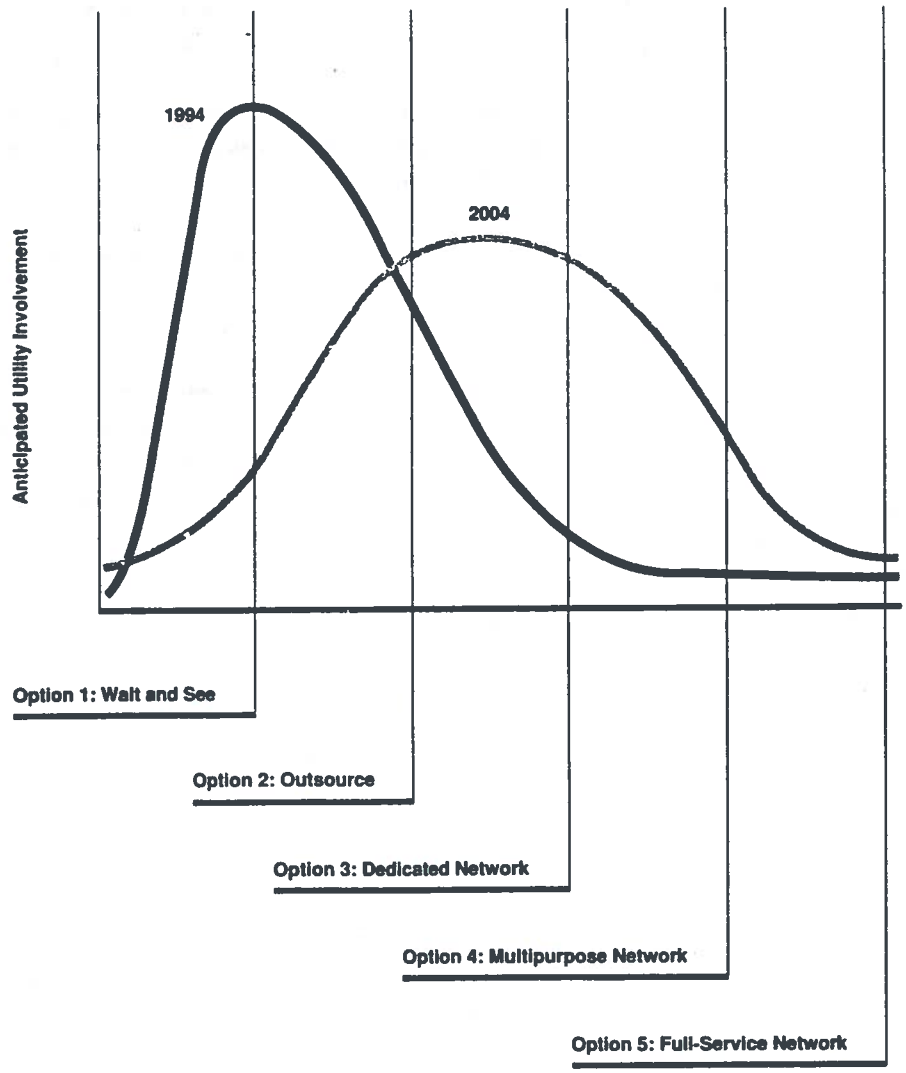
The connection to individual customer premises—the so-called last mile—can be accomplished by conventional twisted-pair conductors, coaxial cable, radiowave transmission, or fiber.

pating customers. The system is currently being deployed in 50 homes in a residential subdivision in Little Rock, Arkansas. By investing $585 to install fiber-optic cable, according to a recent *New York Times* analysis, the company will save an estimated 1.5 kW per house. To supply the same 1.5 kW with new capacity, Entergy would have had to spend $1257 per house. In short, the ability to defer or avoid the cost of building new capacity serves as a powerful economic incentive to install cost-effective demand-side management systems via the evolving information infrastructure.

Deferring new capacity is just the beginning. Advanced information and telecommunications systems will enable utilities to control costs, improve power quality, and even reduce environmental impacts through a variety of innovative initiatives. The installation of electronic sensors and automated control systems linked together along T&D lines, for instance, will provide unprecedented control over the delivery of electric power.

On the customer side of the meter, EISs made possible by two-way communications will enable electric utilities to offer a wide array of new services. In addition to the cost-savings potential of real-time pricing, two-way communications networks will allow for detailed itemized billing (complete with an accounting of consumption by individual appliances or machines), instantaneous remote meter reading, home security systems, and even remote turn-on/turn-off services. "Large customers already expect to be able to manage energy," says EPRI's Marina Mann. "Soon residential customers will expect the same."

UTILITY INVESTMENT PROFILE **While most utilities are currently taking a wait-and-see position on investment in information technology, EPRI believes the industry will become more aggressively involved over the next decade as competition pressures companies to deliver greater value and differentiate their services. EPRI's recent study provides guidance on five investment options.**



At the heart of the issue is competitive position. The evolving information infrastructure is rewriting the rules of competition, creating new links to customers and new means to deliver products and services. "If the utility industry does not move quickly to secure its connections to its customers, other service providers certainly will," warns Mann. Independent EIS providers, for instance, could move in, stepping between power producers and their customers. "And," as Mann emphasizes, "the bottom line of any competitive strategy is simple: Never let anyone come between you and your customer."

Lessons from the telcos

The lessons of the recent past can serve as a useful guide as utilities evaluate the impact of rapidly changing regulations and new business opportunities along the emerging information infrastructure. In 1984, the breakup of the Bell telecommunications system created risks and opportunities similar in many ways to those unfolding today. Who prospered? Who lost market share? "The experience of the telcos should serve as a wake-up call to the utility industry," says Mann. "After the breakup of Bell, the companies that were best positioned in the new markets were those that moved quickly to modernize plants and equipment, to reduce costs, to develop new business ventures through unregulated subsidiaries, and to shape regulatory change in order to ensure open competition."

The first step, according to EPRI's study of risks and opportunities, is for utilities to set in place internal information systems that will enable them to know as much as possible about their own operations, especially their costs. "That means modernizing plants with advanced digital information systems and installing smart substations that will enable utilities to establish the cost of a kilowatthour at any point in time," Mann explains. "With their own internal information systems in place, utilities will be able to respond by establishing costs and access charges when new entrants in the marketplace begin to demand access to existing T&D lines. The same information will be essential for competitive power brokering."

Many advanced information systems specifically tailored for internal utility operations are already available. EPRI's Utility Communications Architecture, for instance, provides communications protocols and standards that allow once-disparate software systems to talk a common language, enabling electric utilities to exchange information more freely. Meanwhile, the EPRINET information network currently gives 7000 users easy access to industry-specific news, e-mail, special-interest bulletin boards, and a library of technical reports and information. At a recent workshop focused on NII issues, EPRI and the Department of Energy agreed to link EPRINET with DOE's ES-Net to improve public access to both EPRI and DOE information. The Institute is also working with several of its members to use EPRINET to create innovative customer energy information systems.

On the supply side, EPRI has designed technologies for fault location and reporting, staggered service restoration, automatic meter reading, and remote service connection and disconnection. On the demand side, EPRI-funded research has played a leading role in developing applications for real-time pricing, direct load management, demand-side management services, power brokering, and improved customer services. A demonstration system for automated real-time pricing installed in New York City's Marriott Marquis hotel, for example, promises to save $200,000 in energy costs the first year, with savings then escalating by 5% a year. Also, a prototype of the Nonintrusive Appliance Load Monitoring System, or NIALMS, has been successfully field-tested. The system will replace conventional load survey systems and provide crucial customer information to utilities.

Eventually, advanced home automation systems will use the information superhighway, providing a powerful tool for sophisticated demand-side management programs. By way of a home automation communications network, for instance, an in-home energy management controller could receive electricity rate information that would then allow residential customers to program appliances to take advantage of the lowest-cost electricity. To facilitate the development of such services, the Electronic Industries Association recently released an interim communications protocol, called Consumer Electronics Bus, or CEBus, which creates a single standard for home automation technology development. Manufacturers have already begun to announce the development of components and products that use CEBus.

Over the past decade, EPRI played a leading role in developing the Smart House, which combines innovative designs for communications protocols and home automation technologies. During the recent workshop on the NII with DOE and the National Economic Council, EPRI discussed the possibility of creating a Smart Town to demonstrate and test the communitywide advantages of intelligent energy and information management, as well as a Smart Grid to create a vision and blueprint for the evolution of the energy system and the information superhighway. According to Skelton, EPRI will take the lead in developing these concepts in 1995.

But exploiting advanced information technologies is only part of a successful strategy for getting involved in the coming information infrastructure. Equally important, the experience of the telcos suggests, is working closely with regulatory agencies to clear the way for unimpeded competition in areas of strategic interest. For now, significant regulatory uncertainties remain. Some utilities are currently prohibited from entering the telecommunications business by the Public Utility Holding Company Act (PUHCA) or by state regulatory bodies, for example. And for utilities that opt to move into telecommunications services, regulators are likely to implement measures to protect electric ratepayers from footing the costs for commercial ventures and to provide competitors with nondiscriminatory access to the utilities' network assets.

Southern Company Services, a strong believer in the potential of communications infrastructure investments to enhance national productivity, job creation, and personal income levels, pointed out in a 1994 report the importance of allowing U.S. utilities to take full advantage of competitive opportunities in an increasingly global information economy: "Other countries have recognized the opportunities and are moving aggressively to capture the benefits of increasing electric utility participation in communications and cable TV services. In England, the Netherlands, Finland, Germany, Denmark, and Japan, for example, electric utilities already utilize their communications networks to offer telephone and/or cable TV services. Public policies in these nations encourage electric utilities to participate in these markets in a variety of ways, from leasing out excess communications network capacities to full participation in cable and TV telephony markets."

Industry observers believe that many of the current regulatory barriers in this country are likely to be lowered or eliminated entirely in the coming years, putting electric utilities in a stronger position to compete directly in the field of communications and information delivery. Anticipating such changes, Mann emphasizes how important it is for utilities to frame the regulatory issues and educate regulatory authorities now about the role of telecommunications in their business, while they are planning their own strategies. "Otherwise, regulatory delays and obstacles could derail even the best-thought-out strategy," she cautions.

Assessing the options

With so many uncertainties, how can individual utilities set a wise strategic course along the information superhighway? To provide a road map of risks and potential benefits, EPRI's intensive five-month study of business opportunities assessed five strategic options. They range from a wait-and-see approach—in which utilities make only incremental investments in current telecommunications systems while waiting to see if other options become more clear—to constructing a full-service network that provides not only a complete range of energy information systems but also local telephone, cable TV, and value-added services.

Although ongoing changes in both the telecommunications and power industries make the first option tempting, EPRI's Ron Skelton warns that it poses significant risks. Alliances and investments made by competitors and EIS suppliers could lure customers away and leave utilities in a race to catch up, he explains.

A wiser strategic choice for many utilities may be the second option, leasing network facilities from independent providers such as telecommunications or cable TV companies. Such a strategy offers the advantages of flexibility and the ability to take advantage of competition among suppliers. But there are drawbacks and risks here, as well. For example, local telephone company service often does not meet utility needs for continuous and fully reliable communications. Moreover, a utility that relies primarily on public networks could in effect be preparing a road map for potential EIS competitors.

The third option, building a dedicated network, ensures that telecommunications and information systems remain under utility control and are closely integrated with all internal systems. But the capital investment required is significant. A dedicated network with a backbone of fiber-optic cable to the substation level, with broadband or narrowband electronics as necessary and coaxial cable or wireless connections to the customer's premises, is likely to require a capital investment of $500 to $700 per customer location in a metropolitan or suburban area. Rural installations could cost twice as much.

Establishing a multipurpose network, the fourth option, would allow utilities to leverage their own information and customer service networks in order to provide telecommunications services to other businesses in their service areas. Indeed, because direct utility use requires only about 5–10% of fiber-optic capacity, some utilities are already selling the excess capacity on their networks. The obvious benefit, of course, is the creation of new sources of revenue and profit provided by diversification.

Although there is some competitive risk in the telecommunications marketplace, the EPRI study concluded that utilities can offset the risk by upgrading a dedicated network only as deals are made with large-capacity users. The single most important consideration, perhaps, is that managing a multipurpose network will require a broader range of skills in planning, engineering, and marketing than most utilities now possess. Regulation will also prove an important issue. Utilities that invest in a network designed to be leased for commercial telecommunications services are likely to be scrutinized more closely by regulators than are those that build a dedicated network for their own internal use. Indeed, multipurpose networks will almost certainly require a separate subsidiary for at least some commercial services.

The fifth and final option, developing a full-service network, would use a fiber-optic and coaxial cable network to provide a full range of services—including two-way voice, data, and video communications and advanced interactive cable television services like video-on-demand. This option has even greater potential for diversification, with commensurate potential for profit as well as a higher level of competitive risk. But utilities can reduce the risk by offering full-service networks only in selected portions of their service areas and extending the networks as competitive conditions dictate. Like a multiuse network, a full-service network is likely to require considerable attention to marketing and strategic planning.

How far, how fast?

"How far a given utility decides to travel along the superhighway will depend on many factors, from capital position to existing markets," says Ron Skelton. In reality, few utilities are likely to have the resources or expertise to develop full-service networks immediately. Instead, most may opt to phase in new markets and technologies—beginning with the development of a dedicated network, for instance, and exploiting competitive opportunities to lease capacity, partner with others, and provide services to customers as the market evolves.

The first priority is likely to be providing energy information systems to large users of power. From there, the network can be extended to communities where market needs, competition, and regulation make new services, such as remote meter reading or real-time pricing, economically attractive. "Wireless communications could be used initially to provide connections for narrowband telecommunications and energy information systems, for example," explains Skelton. "Later, those could be replaced by wired connections as the customer base and the services offered expand." Whatever form phased implementation takes, it is likely to reduce economic risk and ensure the flexibility to adapt to improved hardware and software as they become available.

Another strategy to reduce risk and improve competitive advantage is the formation of strategic partnerships that exploit the strengths of a variety of players in the field. In some instances, utilities may join forces with other utilities to carve out larger geographic areas for service or to increase their deal-making leverage. Partnerships may also bring utilities together with local telecommunications companies. "While utilities have tremendous assets in terms of rights-of-way and customer-billing systems, as well as a tremendous reputation with customers, they typically have less experience in marketing," says Marina Mann. "A telco brings to the table strong marketing and network skills, as well as solid financial and strategic planning experience. Strategic partnerships that are designed to make the best use of a utility's existing rights-of-way, service fleet, fiber investment, and strong customer image for reliability can offer both parties tremendous opportunities and lowered risks."

Partnerships with telecommunications or cable TV companies could also give utilities a strategic way to complete what Mann calls the last mile—the link between large-

Road Map for the Information Superhighway

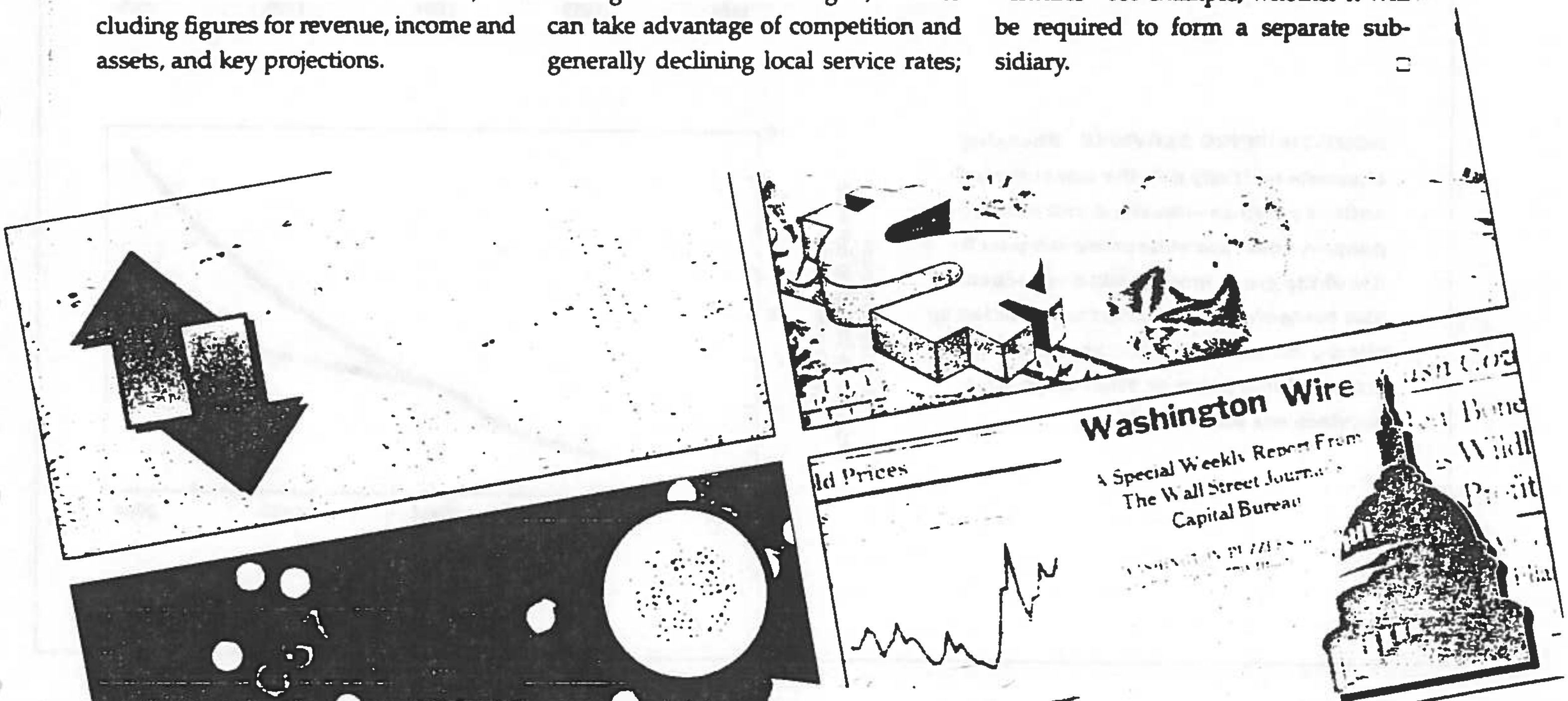
More than just a report, EPRI's *Business Opportunities and Risks for Electric Utilities in the National Information Infrastructure* (TR-104539) is intended to serve as a detailed road map to help utilities plan their own information and telecommunications strategies. "Individual utilities must assess their specific opportunities and define their options in both financial and intangible terms," says EPRI's Ron Skelton. With that in mind, EPRI's team of experts analyzed strategic issues from four key industry perspectives: market risks and opportunities, emerging technologies, financial considerations, and public policy issues.

Market risks and opportunities As the National Information Infrastructure evolves, utilities are confronting enormous opportunities and risks. The report evaluates the opportunities both for internal applications of utility networks and for potential profit-making external uses, such as leasing out unused capacity or offering competitive telecommunications services. The report analyzes the competitive position of utilities in relation to other major players, such as telephone and cable companies. Of special interest is a detailed overview of the major segments of the telecommunications market, including figures for revenue, income and assets, and key projections.

Emerging technologies Fiber optics has emerged as the leading technology for the information infrastructure. But wireless and satellite communications systems will also play a significant part. As the report notes, there are currently more technologies than the marketplace knows what to do with, suggesting that many opportunities exist to define new services for both internal and external purposes. The report details a wide range of technological options available to utilities and other competitors on the information superhighway—from modulation and channel-sharing techniques to satellite networks. For each technology, specific opportunities for electric utilities are reviewed. The report also includes a table listing applicable network technologies that utilities may choose to employ in the future.

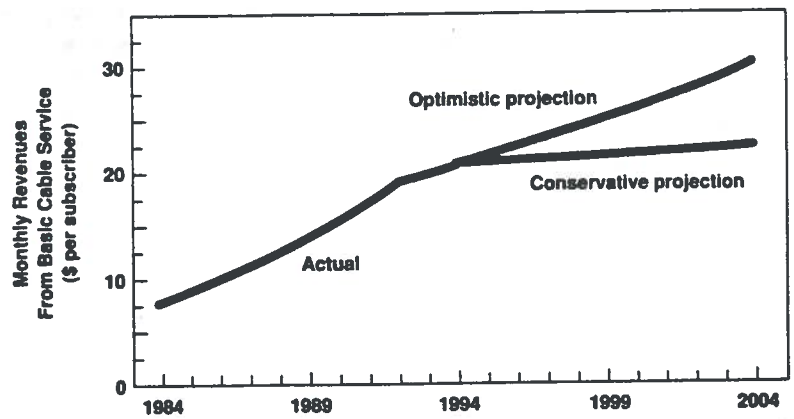
Financial considerations Because telecommunications networks are capital-intensive, financing will be a major factor in setting strategies. In analyzing each of five possible options—from the cautious wait-and-see approach to the aggressive strategy of developing a full-service network—the report details specific costs and financing considerations. For instance, by adopting the option of leasing network technologies, utilities can take advantage of competition and generally declining local service rates; however, the unpredictability of market rates for telecommunications services will also make the long-term costs of that option difficult to quantify. To further guide utilities, the report reviews a variety of risk mitigation strategies, including partnering and phasing in network capabilities and expanded service regions over time.

Public policy issues Despite sweeping regulatory changes, utilities still must balance their societal mission with any profit-making ventures in the telecommunications field. The report points out that universal-service goals—including the extension of information services to schools, hospitals, and public institutions—may enable utilities to fund networks in part from public or universal-service funds. But utilities must also take into account current and potential regulatory constraints in the electricity and telecommunications industries. As a guide, the report reviews in detail the 1993 revisions in the Public Utility Holding Company Act and anticipates future trends. It concludes that barriers will continue to be removed but that regulatory issues are still likely to affect the way in which an electric utility may structure its telecommunications ventures—for example, whether it will be required to form a separate subsidiary. □

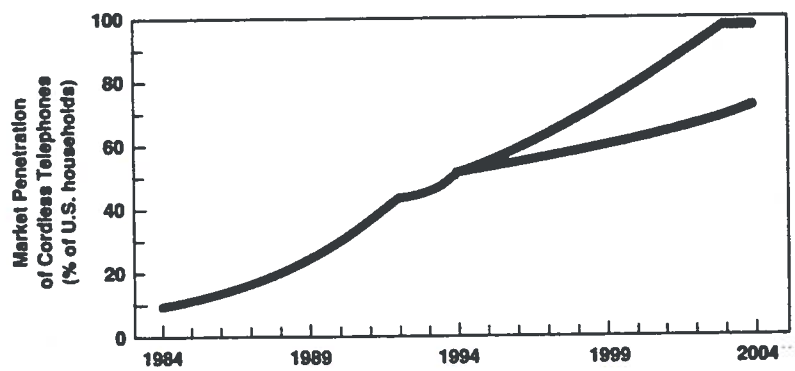


OPPORTUNITIES FOR MARKET EXPANSION As development of the information superhighway expands the ability to interact directly with consumers, markets for information services are expected to grow steadily. Utilities with extensive optical fiber assets could become involved in a number of these telecommunications markets, either by leasing some of their fiber capacity to other companies or by forming subsidiaries to actually provide service. In addition to the existing market segments shown below, there is growing potential in such emerging areas as video conferencing, on-line computer services, e-mail communications systems, and remote monitoring and security systems.

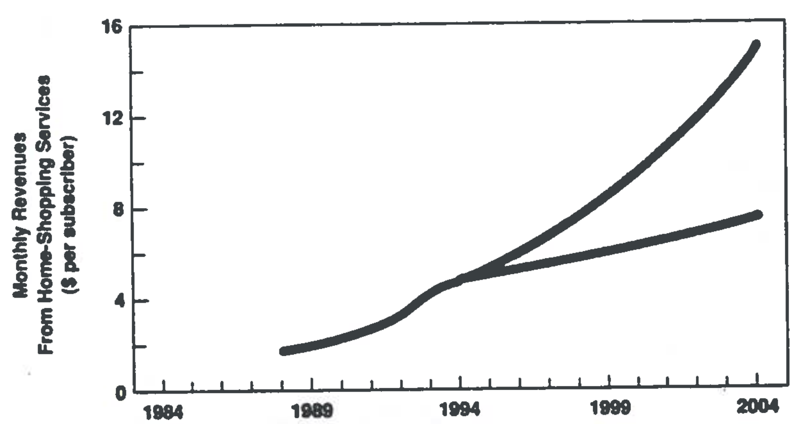
CABLE TV SERVICE Although the cable industry is facing increased regulation and rate limits for basic television service, new services such as digital music channels, telephone dial tone, and data transmission could still mean revenue growth. Some cable companies may offer utilities equity positions in exchange for help in upgrading their systems.



WIRELESS TELEPHONE SERVICES Cellular and other cordless telephone services continue to grow at the expense of conventional hardwired technology. The development of low-cost communications services that use microwave frequencies and very small cells would significantly improve the versatility and convenience of personal telecommunications.



HOME-SHOPPING SERVICES Shopping channels typically pay the telecommunications provider—usually a cable company—a small per-subscriber fee plus 3–5% of the gross merchandise revenues. The home-shopping market is expected to show substantial growth, especially if video catalog sales or other innovative services are introduced.



scale fiber-optic networks, which can be strung along existing rights-of-way, and customers' homes. "It's that last mile that represents the most significant cost in providing a multipurpose or full-service network," says Mann. "And since cable TV companies already reach nearly 70% of all homes, and phone companies nearly 90%, alliances between utilities and such firms may have significant strategic advantages."

In one scenario, a utility might opt to collaborate with cable operators in its service area to develop a multipurpose or full-service network. Upgrading an existing cable installation is estimated to cost about $300 less per customer location than putting in a whole new system. Such a collaboration would enable cable operators to upgrade their capabilities and realize the economies of a network spanning an entire metropolitan area; for utilities, collaboration would open up new synergies in marketing, field service, and billing.

Taking the lead

Several such alliances have already been formed. Houston Lighting & Power, for instance, has purchased a local cable TV company. Pacific Gas and Electric has signed agreements with Microsoft, the giant software developer, and TCI, the nation's largest cable TV company, in an effort to take the lead in developing energy information systems and making them available across a wide service area.

This past November, a federal deadline for companies intending to bid on licenses for a new generation of wireless personal communications services touched off a frenzy of announcements about new—and sometimes startling—alliances between major players in the communications, entertainment, and information industries. In one of the most highly publicized examples, Hollywood's largest talent agency joined forces with three major telecommunications companies on the East and West Coasts in a venture designed to offer entertainment services that will operate via phone and be viewed on small TV sets.

Meanwhile, a growing number of utilities are moving more quietly to secure their place on the information superhighway. In most cases, that has meant adding fiber-optic lines to their systems, typically using existing rights-of-way. In recent years, Public Service Company of Oklahoma has created a 110-mile fiber-optic loop around the Tulsa area, which it is currently using both to meet its own communications needs and to provide high-volume data transfer service to some 30 commercial customers.

Adopting a similar strategy, Baltimore Gas and Electric has installed 230 miles of fiber-optic cable inside existing ground wires to connect its corporate offices to 30 of its main power sites and offices. Because BG&E uses only a fraction of the carrying capacity of the fiber-optic lines, the utility has been able to lease the unused capacity to others, including a major long-distance carrier.

SCANA Corporation has moved even more aggressively, forming a telecommunications subsidiary that has installed more than 1600 miles of fiber-optic cable on overhead power lines owned by its sister subsidiary, South Carolina Electric & Gas. An additional 600 miles are planned. Meanwhile, the Southern Company is setting up a new subsidiary, Southern Communications Services, to operate a unified wireless communications network to serve its five operating companies. The combined voice and data network will be used for emergency communications between managers and Southern crews in different states during storm emergency situations. The company also plans to sell excess capacity on the network in order to offset the capital cost and to gain economies of scale.

Even smaller players have found a lane on the information superhighway. Consider the Kentucky town of Glasgow (population 13,000). In 1988, the town's municipal utility, the Electric Plant Board (EPB), began to wire homes with cable. The aim was not only to read meters remotely and exchange data with customers but to go head-to-head with the area's monopoly cable company, according to William Ray, EPB's general manager. To date, the muni has lured away some 30% of the cable business. It is now looking at providing competitive telephone service.

Fiber optics are not the only link in the growing information infrastructure, of course. EPRI's report on business opportunities and risks evaluates more than a dozen telecommunications technologies that are likely to play a significant role on the information superhighway, including wireless telecommunications, point-to-point microwave circuits, and geostationary and low earth-orbiting satellites.

The power of information

As recent alliances make clear, the traditional boundaries between electricity providers, telecommunications companies, cable TV operators, and even interactive entertainment companies are quickly fading as information becomes the principal commodity, whether in the form of telecommunications, cost-saving energy information systems, entertainment, e-mail, or access to the world's libraries through a growing number of databases.

In that context, the National Information Infrastructure is simply the latest step in an economic and social transformation that began almost 75 years ago. As management guru Peter Drucker has pointed out, competitive advantage in the early part of the twentieth century depended principally on obtaining cheap energy—whether in the form of oil and coal or through innovations, like the assembly line, that made more productive use of human energy. Since then, chiefly as a result of technological change, competitive advantage has come to depend on the acquisition and application of information, Drucker notes.

For the better part of the century, electric utilities have been at the forefront of that revolution, providing the power for progress—not only by supplying reliable electricity but also by fostering innovative technologies that have extended what electricity can do. Today, as the United States and other industrialized nations begin to link up myriad communications networks and information technologies in a vast electronic superhighway, utilities once again are positioned to play a central role in tapping the transformative power of electricity. ■

Background information for this article was provided by Marina Mann and Ron Skelton of the Strategic Development Group.

COMMENTARY

By Mark Lewyn

HOW TO VAULT THE FINAL HURDLE TO TELECOM REFORM

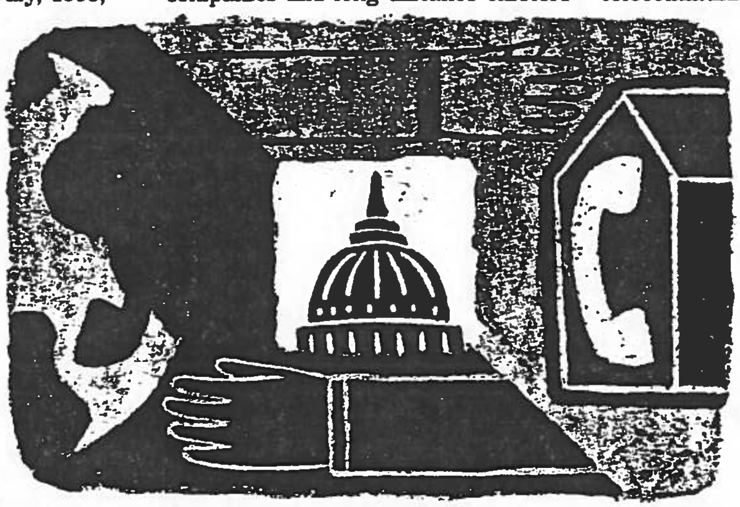
Back in January, 1985, Metro-Link Telecom Inc. started offering phone service between Houston and nearby Galveston, Tex., by leasing lines from SBC Communications Inc., the regional Bell operating company. After two years, the Texas City upstart had wrested 200 big corporate customers from SBC. Then the Baby Bell launched a counterattack. According to an antitrust suit that Metro-Link filed, SBC tried to squash its smaller rival by removing Metro-Link numbers from its phone directories and refusing to assign it any new numbers. SBC officials deny they tried to kill off the competition, but in July, 1993, Metro-Link was awarded $5.7 million in damages, which SBC is appealing. "They will stop at nothing to stop competition," says Daniel A. Jones, a Metro-Link co-owner.

Metro-Link's experience points up the thorniest issue facing Congress as it attempts to rewrite the laws that regulate the sprawling U.S. telecommunications industry: how to dismantle the local-phone monopolies run by the Baby Bells, GTE Corp., and 1,300 smaller players across the nation—and quickly introduce the free-for-all in local calling that has benefited long-distance consumers for a decade.

BEDEVILED. Granted, virtually all interested parties are in agreement on the endpoint of new legislation. In return for freedom to enter new businesses such as long distance and cable TV, local-phone companies must open their markets to competition. The devil is in the transition rules that the different parties want put in place to ensure that the local phone giants do indeed open their markets.

Republican lawmakers have proposed a Bell-friendly "date-certain" measure. It would say, in effect, that as of a certain date the Baby Bells can enter cable, long distance, or any other business, whether or not competition exists in their local operating regions. Democrats, more closely allied with long-distance carriers, favor some form of test to determine whether a Baby Bell's local market is competitive before it can jump into long distance.

There are big drawbacks to both approaches. Senate Republicans, led by Larry Pressler of South Dakota, are pushing a proposal to introduce legislation that lets the Bells into long distance after three years. The GOP figures that would give cable companies and long-distance carriers enough time to penetrate local calling. Even before that, the Bells could enter the cable-TV market to help break up that monopoly.



The trouble is, the Baby Bells would still have every incentive to continue blocking or delaying competition. While the Republican measure includes penalties of up to $500 million for delaying tactics, experts say the billions of dollars in revenues from preserving the local monopolies would more than offset the fines. The date-certain approach is "very poor public policy," says John W. Mayo, an economics professor at the University of Tennessee.

The Democratic alternative—a rerun of last year's Senate bill—would be no better. It calls on the Justice Dept. to decide whether there is a "substantial possibility" that the Bells could impede competition in local markets and requires the Federal Communications Commission to decide whether freeing the Bells would be in the public interest. But this subjective approach confers too much power on regulators. Worse, it could spawn litigation over the definition of "substantial" that might take years to settle, further postponing the benefits of competition.

EQUAL CHANCE. The smartest strategy is contained in a bill to be introduced shortly by Jack Fields (R-Tex.), chairman of the House telecommunications & finance subcommittee. His plan lays out objective criteria for determining whether a market is open. For example, customers must be able to keep their same phone numbers, with no extra digits added, no matter who their local carrier is. Interconnections with the existing network must be offered to new entrants at competitive rates. And local-phone companies must "unbundle" services they sell so that rivals can buy just what they need—leased lines, for instance—and not be made to buy things they don't want. Once state regulators say the competitive "checklist" is complete, the FCC would give the Bells the green light.

This proposal would provide a sound framework for full competition in local-phone service. It doesn't assure that anyone will take on the Bells successfully. But the government can't guarantee how market forces will play out—only that all comers will have an equal chance. Fields is proposing fair rules for the race. It's time to let it begin.

Lewyn covers communications policy from BUSINESS WEEK's Washington bureau.

Case Studies: What Lessons Do They Provide?

ITS Communications Infrastructure Case Briefs

Intelligent Transportation Systems (ITS), in particular Advanced Traffic Management Systems (ATMS) enable highway operators to detect traffic incidents and adjust traffic control devices and initiate emergency response actions tailored to the situation. Typically, ATMS rely on remote video surveillance to monitor and assess traffic conditions. Thus, high-bandwidth communications networks are a critical pre-cursor to ITS deployments involving ATMS or the traffic information produced by such systems.

When contemplating ITS deployment, a public agency must determine how it can best meet the need for supporting communication services. In general, there are two basic choices: 1) purchase service from private telecommunications providers and 2) develop dedicated, agency-owned facilities that can be operated by the agency directly or under contract, by private firms. A third option is possible through variations on either of the basic options through the use of innovative public-private arrangements. Typically, these involve public agency accommodation of private telecommunications infrastructure on highway right-of-ways in exchange for communication services or specific communication infrastructure for ITS purposes.

In order to better understand how public agencies are addressing the need for advanced ITS communications infrastructure, several recent examples involving fiber optic communication systems have been examined and summarized in case briefs. The case briefs illustrate different situations and choices confronted by various public agencies. Thus, the cases provide a useful common basis for group discussion concerning how public agency communications needs for ITS can be satisfied cost effectively.

ITS Communications Case Brief Overview

Case Location	ITS Applications	Leased Service	Owned System	Shared Resource
Boston Central Artery / Tunnel	ATMS, Electronic Toll Collection, and Ventilation Control		✔	
CONNDOT / I-95	ATMS		✔	
San Antonio, TX	ATMS		✔	
San Jose, CA	ATMS	✔	✔	
Missouri DOT	ATMS	✔		✔
New Jersey Highway Authority	ATMS	✔		✔
Bay Area Rapid Transit System	Emergency Communications		✔	✔

The case briefs provide instructive insights into public agency decision criteria and processes. Overall, agencies appear to place a very high value on communications reliability and control, although this is tempered markedly by cost considerations. In most instances, agencies appear cautious, but not reluctant, to undertake ownership and operation of fiber optic communications technology, particularly when doing so provides some margin of protection against future cost escalation and greater control over operations and maintenance.

Shared resource arrangements are becoming increasingly common as public agencies and private telecommunications providers both seek to achieve cost efficiencies. However, institutional mechanisms have yet to mature to where these arrangements are considered routine. Moreover, public agency acquisition preferences for single vendor ITS accountability makes separate arrangements for supporting communications less common. Often consultants and/or ITS vendors are afforded considerable latitude over communications system acquisition strategy, with the provision that they cover operating and maintenance costs for some period to ensure life-cycle costs are not discounted in order to achieve a low system acquisition cost advantage.

The process by which ITS communications infrastructure decisions are made varies depending upon a variety of factors. These include the scope of the initiative (project, corridor, metropolitan, statewide, regional, etc.), the source of financial resources, the existence of shared resource opportunities, and technical capabilities resident in the agency. The case briefs suggest a number of questions regarding the decision process overall, and how it might be improved to provide for ITS needs more cost effectively. These include:

- Would communications life-cycle cost comparisons among leased, owned, and shared resource options result in different decisions or just add cost and complexity to ITS deployment? If such analysis would be helpful, what factors should be included?

- Do perceived institutional barriers or acquisition bias factors exist? If so, what are these specifically?

- What protections, if any, are needed to ensure that government agencies do not inappropriately deploy and operate dedicated ITS communications infrastructure in competition with commercial service providers?

- Do ITS procurement practices, particularly the emphasis on single vendor accountability, need to be restructured to ensure the public does not inadvertently foreclose advantageous options?

- What impact does government agency deployment and operation of ITS dedicated fiber optic communications have on private initiatives to deploy an advanced national telecommunications infrastructure? How or to what extent should such effects be considered in a transportation agency's decisions?

Massachusetts Case Study: Central Artery (I-93) / Tunnel (I-90) Project

I. Overview

The Central Artery / Tunnel (CA/T) is a multi billion dollar project to replace Boston's elevated Central Artery (I-93) with a subsurface expressway and to construct a third harbor tunnel to Logan International Airport accessible from the Massachusetts Turnpike (I-90). The CA/T comprises 7.5 miles of roadway, most of which will be covered or submerged. The project is currently administered by CA/T management under the Massachusetts Highway Department (MHD). However, the state will probably transfer control of the CA/T system to the Massachusetts Turnpike Authority (MTA).[1] The CA/T project includes the deployment of a fiber optic network to support monitor and control of speed limit and lane change signs, variable message signs, closed circuit television (CCTV) cameras, and other Intelligent Transportation System (ITS) components.

Essential characteristics for the communications system were identified in a 1990 concept report prepared by Bechtel / Parsons Brinckerhoff, including the need for highly reliable voice, video, and data communications.[2] The report concluded that the communications system should rely upon a fiber optic backbone and that the state should adopt a policy "on the selling or leasing of publicly funded spare conduit space and spare cable capacity to private revenue producing companies."[3]

The Bechtel / Parsons Brinckerhoff report was reviewed and endorsed by at least three entities; CA/T management, the Massachusetts Highway Department (MHD), and the US Department of Transportation (USDOT). This process involved the design managers and project directors for the state and within CA/T management. The state decided to build and maintain its own fiber optic network which, when completed in 2001, will be about 7.2 miles long and will cost the state about $20 million.[4] At this time, MHD has no plans to lease reserve communications capacity to the private sector.

II. Description of the deployment under consideration

The project planners wanted to minimize potential disturbances to the communication system induced by electromagnetic interference, and other physical and environmental phenomena. There was a clear recognition that standardized signal

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1 Pending legislation in the Massachusetts legislature would give the MTA authority over the CA/T system. (see Boston Globe 3/31/95 p.45)

2 "Central Artery (I-93)/Tunnel (I-90) Project: Communications Systems", Concept Report No. 2AB10, Bechtel/Parsons Brinckerhoff, October 1990

3 Concept Report, p.10

4 Cost includes controller equipment, single mode fiber, and multimode fiber. The multimode fiber is used to connect system components such as video cameras to the main backbone.

transmission technologies should be adopted to ensure network compatibility, extensibility, and reliability.

These functional needs led to the selection of a fiber optic backbone for the communications system. Alternatives including microwave, twisted pair copper wire, and coaxial cable were also considered. Each medium was rated on the basis of coordination, integration, compatibility, flexibility, and maintenance/service ability. In each category, fiber was determined to be superior. Specifically, fiber does not require intermediate repeaters, and is less susceptible to electromagnetic interference than alternative mediums. Moreover, the relatively small cable diameter conserves conduit space which is limited and may be required for future applications. Fiber is capable of supporting a wide range of delivery needs including voice, video, and data transmissions.[5]

In September 1993 a Request For Proposal (RFP) was issued for the third harbor tunnel portion of the communications system which would be owned and eventually operated by MHD.[6] A single RFP was utilized to keep costs down and focus accountability. The RFP covered monitor and control of speed limit and lane change signs, variable message signs, emergency telephones, a closed circuit television system, heat detection and fire alarms, and the control system for ventilation fans. NYNEX did not bid in this phase of the project presumably because the scope was significantly broader than its established line of business.[7]

Perini-Powell was selected in January 1994 as the general contractor for the communications system development. The contract required Perini-Powell to utilize off the shelf equipment to satisfy all of the system's requirements in order to avoid unforeseen problems. The contractor will receive $8.6 million for installing the multi and single mode fiber network.[8] A second RFP will be issued for the remaining portion of the

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5 A fiber optic network could also be integrated in the MTA's communications system to provide additional capacity and redundancy, and contribute to the development of a seamless state wide network for transportation communications.

6 The RFP required the contractor to have initial responsibility for operating the system.

7 However, NYNEX could have worked as a subcontractor to Perini-Powell. To the author's knowledge, no telecommunications company has called into question the CA/T communications system project.

8 According to a press release from Perini-Powell dated March 22, "The Perini/Powell joint venture will design and install a fully-integrated traffic control system that will maintain the surveillance of traffic along Boston's Central Artery and Third Harbor Tunnel by means of a sophisticated computer system. The system will monitor and control 118 speed limit and lane change signs and 39 variable message signs providing current traffic information. In addition, the division will also furnish and install an emergency assistance radio system, an emergency telephone system, a closed circuit television system, a heat detection and fire alarm system, and

communications system. The fiber backbone for the second phase is expected to cost about $11 million. The total CA/T single mode backbone will be approximately 7.2 miles long when completed in 2001 and, including controllers and multimode fiber, will cost about $20 million.

The CA/T fiber network is based upon the Synchronous Optical Network (SONET) standard to ensure ease of future upgrades and system maintenance. Network capacity is OC-3 or 155 Mbps. At least five different vendors could have provided the fiber backbone. Perini-Powell is using AT&T as the system vendor for the project.

TABLE I - FINAL NETWORK CHARACTERISTICS

project	standard	vendor	capacity	fiber type	system length	total cost
CA/T	SONET	AT&T/?	OC-3	mixed	7.2 miles	$20 million

* *"capacity" refers to the speed of the backbone*

* *SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

* *"system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

III. Description of the key decision factors

The key factors influencing the state's decision to buy rather than lease a fiber optic network were cost, reliability, and availability of leased infrastructure. Planners also considered operations and maintenance issues.

According to project planners there was no cost alternative to procurement in 1990 and "its difficult to imagine one right now." Video applications for the network require broadband transmission capacity which is typically very expensive to lease. Cost analyses carried out by technical and estimating staff showed that procurement was the only viable alternative for the state. From the perspective of CA/T planners, the choice may have been obvious since leasing could have been about five times more expensive.[9]

System reliability was also a critical decision factor. The 1990 concept report clearly states the need for a highly reliable communications system. In an interview, project planners expressed doubts about the ability of the private sector to ensure sufficient reliability using the public switched network because communications service providers have multiple customers and therefore may not prioritize CA/T communications. Moreover, public switched network upgrades unrelated to the CA/T system could cause

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the control system for high-capacity ventilation fans. Work on the project will begin immediately with completion scheduled for June 1998." The total contract award is for $52 million.

9 However, in an interview, project planners were unable to identify a formal project report in which system costs were identified.

network failures that would otherwise not occur if the system were wholly owned and operated by the state. Although service contracts can be arranged with system reliability clauses designed to assure the buyer that network failure will not occur, state planners suggested that these clauses may be useless in preventing system failure. In an interview, project engineers suggested that the required mean time before failure (MTBF) of the system needs to be five years or greater, but that the public switched network MTBF is typically less than one year.[10]

Aggregate operations and maintenance costs for the entire CA/T project were repeatedly reviewed by the Project Director, and will continue to be reviewed on a periodic basis. The RFP for the communications system included life cycle costs for the first five years of system operation and maintenance to encourage Perini-Powell to consider operations and maintenance costs in designing the communications system.

According to project planners, in 1990 when the concept report was prepared private companies were just getting started with fiber deployments in the area and may not have been well positioned to meet the communications needs of the CA/T system. At this time, NYNEX, MFS, and Teleport are major telecommunications service providers in the Boston area. NYNEX, a regional bell operating company, is the main local access provider in Massachusetts. MFS and Teleport are competitive access providers (CAPs) that compete with NYNEX in the region.

IV. Policy on leasing reserve capacity

The 1990 concept report specifically recommends that the state adopt a policy regarding leasing reserve capacity. Although the overall report was endorsed by the project managers involved in the deployment, no formal policy was adopted. However, it is standard engineering practice to build as much as 50% extra capacity for potential future needs. No plan exists to systematically lease reserve telecommunications capacity for the CA/T system.

Although there is no official policy to lease reserve telecommunications capacity, a policy was established to reserve conduit capacity for future needs. The Boston Transportation Department has expressed an interest in using conduit capacity in the third harbor tunnel. However, according to state planners, much of the right-of-way for the rest of the CA/T system may not be marketable because it is 70 to 100 feet below the earth's surface, and therefore not easily interconnected to surface level telecommunications customers.[11]

V. Future developments and related projects

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10 In this context, MTBF refers to critical failure where the system does not to recover within a specified period of time.

11 This suggests that the state may not have been well positioned to trade right-of-way access for communications capacity in the CA/T.

Project planners are confident that the system can easily be upgraded using "off the shelf" components supplied by an equipment vendor responsible for ensuring that its products provide for sufficient interoperability and extensibility. CA/T management expressed confidence that the equipment selected by Perini-Powell is high quality and meets all of the project specifications. Life cycle cost data suggests that Perini-Powell will successfully make a profit from the project. A second RFP will be issued in 1998 for the remainder of the communications system.

It should also be noted that at this time the Commonwealth is actively working to exchange right-of-way access for dark fiber along the state's highways.[12] For example, the MTA obtained fiber under a contract with four telecommunications companies that paid an estimated $25 million to deploy the fiber and will pay the state about $50 million over 30 years to access the turnpike's right-of-way.[13] The MTA paid an estimated $5.5 million and received 12 fibers as part of the deal.[14] In a recent arrangement the MTA agreed to allow the Commonwealth of Massachusetts to use four of the twelve fiber optic lines that it controls spanning 100 miles along I-90 from east Boston to Westfield, Massachusetts. The state plans to continue to pursue arrangements such as this for the purpose of developing the state's telecommunications infrastructure. The MTA's fiber network will eventually be integrated into the CA/T communications system.

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12 The MHD's policy is described in "Wiring Massachusetts: An Agenda for Public / Private Cooperation to Facilitate Deployment of Telecommunications Systems Along Massachusetts Highways" (Commonwealth of Massachusetts, Executive Office of Transportation and Construction, MHD). The report specifically states "In exchange for the rights to the highway Right-of-Way and other property, the MHD will receive system capacity. For optical fiber conduit systems, the MHD will receive exclusive use of the "Commonwealth Component", defined as, three 1.5 inch diameter conduits, lateral branching, manholes and handholes where ever a participant requires the same, and lateral branching for the MHD's Intelligent Transportation System equipment. For tower facilities, the MHD will receive exclusive use of reserved tower space including all tower connections and structural support and electrical power supply required for the Commonwealth's equipment. The Commonwealth Component shall be deemed to be a shared cost among all participants in the Telecommunications Facility and shall be constructed and maintained by the Lead Company. Thereafter, and upon completion of construction, title to all improvements on the premises shall vest in the Commonwealth, excluding any participant's Personal Property. As this initiative currently anticipates optical fiber cable and wireless tower facilities, other Telecommunication Facilities will require separate negotiation."

13 The Massachusetts Turnpike Authority has an explicit policy not to lease reserve capacity but does lease conduit capacity and exchange conduit capacity for communications capacity.

14 "State will get lanes on 'Information Turnpike'", Boston Globe, December 3, 1994

Connecticut Case Study: I-95 Incident Management System

I. Overview

The Connecticut Department of Transportation (ConnDOT) is presently deploying an incident management system along the I-95 corridor from the New York State boarder east through Branford, Connecticut. The corridor has above average problems with congestion which is caused in part by highway incidents and can be reduced using incident management techniques. The primary goals are to reduce the length of time required to detect an accident and the amount of time required to verify and respond. High resolution video surveillance cameras will allow incidents to be monitored from an operations center which will then provide traveler information, such as alternate route recommendations, to motorists. A broadband, fiber optic backbone was deployed by Rizo Electric for ConnDOT to facilitate these applications.

Consulting advice for the project was provided to ConnDOT by Parsons Brinckerhoff Quade & Douglas, Inc. Construction of the incident management system began in October 1993 and is nearing completion. The system will eventually include 91 cameras and 217 radar detectors which will service 56 miles of roadway. A fiber network was installed along I-95 and additional fiber loops are in place for future expansion.

II. Description of the deployment under consideration

Parsons Brinckerhoff Quade & Douglas, Inc. was hired in 1992 to research and design the incident management system taking into consideration technical tradeoffs of various communications system designs. Based upon their recommendation, ConnDOT decided to deploy a fiber network because it is immune to electromagnetic interference, offers broadband, real-time service for video surveillance applications, and has a relatively small cable diameter which conserves conduit space.

A Request For Proposal (RFP) for the system was released in late 1992 / early 1993 that provided for individual contracts to install conduit for each of three contiguous sections of I-95. The contract for the middle portion of highway included pulling the fiber and installing the electronics for the full 56 mile deployment. ConnDOT believed that a single contractor would not be capable of deploying the conduit quickly enough to meet the department's goals. Rizo Electric was awarded the contract to install the middle section of conduit and the Intelligent Transportation System (ITS) components including the communications system. Ducci Electric and Semec handled the remaining conduit installation contracts. The conduit is presently in place and Rizo Electric is nearing completion of the incident management system.[1] The full cost of the deployment, including conduit, is about $26 million of which 80% is funded by the US Department of Transportation (USDOT) Federal Highway Administration (FHWA).

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1 **According to staff, the system is roughly 75% complete with work remaining on the system's software.**

The first two years of operations and maintenance will be handled by Rizo Electric. ConnDOT will consider continuing out-sourcing operations and maintenance after the two year period. SmartRoutes is under a two year contract to operate the traffic control center.[2]

TABLE I - FINAL NETWORK CHARACTERISTICS

project	*standard*	*vendor*	*capacity*	*fiber type*	*system length*	*total cost*
CT - I-95	See note below	Siecor (fiber) Meridian (transceivers) Signal Control Co. (controllers)	See note below	SMF	56 miles	$2-3 million

** A "standard" is not identified because the fiber optic communications application is limited to point-to-point service between the traffic control center and CCTV cameras. However, the system eventually may be upgraded to SONET for interconnection with other systems.*

** Similarly, backbone "capacity" is not identified because the present network architecture does not include a backbone.*

** SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

** "system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

III. Description of the key decision factors

The decision to own the fiber communications system rather than lease capacity was made within ConnDOT and was supported by the Department's Commissioner. No study was performed to determine the cost-effectiveness of each option.

The decision factors were not involved or sophisticated. ConnDOT simply wanted an owned system because the Department's philosophy is to own the infrastructure that it requires to carryout its mission. The one decision factor that was identified is that there was some concern that a leasing arrangement would take longer to arrange and could delay implementation of the incident management system.

ConnDOT did not investigate the extent to which Southern New England Telephone, or another telecommunications service provider, could have provided sufficient communications capacity. No reliability study was performed to ascertain whether leasing, owning, or out-sourcing would be the most effective strategy. A decision was made to simply have an outside contractor handle operations and maintenance.

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2 Note that ConnDOT staff are in the operations center monitoring the work.

IV. Policy on leasing reserve capacity

At this time, ConnDOT does not have any plans to lease reserve capacity to other organizations because built-in reserve capacity is needed to support future ITS deployments. Moreover, the department has never leased capacity in the past. There are no formal efforts to review this policy.

V. Future developments and related projects

The I-95 incident management system is viewed as an initial deployment for a future statewide system. There is no time frame for further projects but early deployment studies for statewide ITS are being conducted.

Texas Case Study: San Antonio

I. Overview

The Texas Department of Transportation (TxDOT) - San Antonio District is developing an Advanced Traffic Management System (ATMS) that will provide transportation and law enforcement officials with real-time information about accidents and incidents on the San Antonio highway system.[1] The traffic management system includes variable message signs, closed circuit television (CCTV) cameras, vehicle detectors, and signaling for intersections and lane control. The deployment will eventually service 191 miles of highway, of which the initial 26 miles are nearing completion at this time. The San Antonio project includes the development of a fiber based communications network to support the ATMS.

The design of the ATMS was solely determined by the TxDOT - San Antonio District. No consultants were involved in the design process.

AlliedSignal Technical Services was the low bidder for the initial deployment and is building a fiber optic network for the Intelligent Transportation System (ITS). The cost of the fiber network for the first 26 miles of roadway, including controllers, is $5-6 million. The District will wholly own and operate the infrastructure when it is complete.

II. Description of the deployment under consideration

Five "aerospace companies" bid to construct the initial 26 miles of the ATMS.[2] The Request For Proposal (RFP) identified the complete design and scale of the system and bundled construction of the communications system with other ITS components. The $32 million contract was awarded to the low bidder AlliedSignal Technical Services which will install the ATMS including the operations control center and the communications system. The 26 mile stretch will include 50 variable message signs, 59 CCTV cameras, 359 lane change signals, 800 loop detectors, and 15 signalized intersections.

TABLE I - FINAL NETWORK CHARACTERISTICS

project	*standard*	*vendor*	*capacity*	*fiber type*	*system length*	*total cost*
TX - SA	SONET	AT&T	OC3	SMF	191 miles	?

** "capacity" refers to the speed of the backbone*

** SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

** "system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

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1 Note that the Texas Department of Transportation has 25 districts.

2 During the interview, the bidders were described as "aerospace companies."

RFPs will be issued for remaining portions of the ATMS which will eventually service 191 miles of highway with about 500 CCTV cameras and 300 variable message signs.[3] The overall cost for the ITS deployment is estimated at $151 million. The backbone will utilize the SONET standard and will run at OC3 speeds. The network is fully redundant and uses single mode fiber.

III. Description of the key decision factors

The decision to develop an owned infrastructure was made in-house by the TxDOT - San Antonio District office. The district is centrally responsible for setting deployment priorities and designing systems, and does not need permission from TxDOT in Austin to deploy new infrastructure. However, approval from the Federal Highway Administration (FHWA) was necessary because 80% of the funding for the deployment is being provided by the federal government. Outside consultants did not contribute to the decision to own rather than lease the communications system.

A formal study of lease/own trade-offs was not completed because telecommunications capacity was clearly not available and the cost disadvantages of leasing were "obvious." South Western Bell, the regional bell operating company, did not have the necessary infrastructure in place to support broadband communication which typically requires at least DS3 (45 Mbps) capacity.[4] Moreover, even if DS3 lines were in place, the leasing option could have been rejected on the basis of cost alone because broadband capacity is typically very expensive to lease.

Reliability was not a decision factor. Leased services are probably sufficiently reliable to support transportation applications. Although it was noted that not all transportation district offices are equally capable of handling operations and maintenance for complex ATMS, staff at the San Antonio district office expressed confidence that the district has the personnel needed to ensure system reliability.

IV. Policy on leasing reserve capacity

Many public and private sector organizations have tried to gain access to the fiber capacity being installed by the San Antonio District. The system is designed with sufficient communications capacity for future ITS needs but no extra capacity is being built. The present policy is not to lease capacity. The District may examine this issue in the future.

V. Future developments and related projects

Thus far, the District is satisfied with the deployment and no technical problems have arisen. The system will become part of a regional traffic management system which

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3 A second RFP will be issued for another segment of the 191 mile system in a few months

4 DS0 (64 Kbps) and DS1 (1.5 Mbps) are not fast enough to support full motion video.

will be operated out of the San Antonio control center. Eventually the system could extend across a 50,000 square mile region.[5]

The San Antonio District is considering leveraging its right-of-way for future deployments. The utilities use the right-of-way now, but preferred access could be offered.[6] If there are future cost advantages for leasing capacity from a private carrier, the District will consider this option for future deployments as well.[7]

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5 The region is comparable to the size of Pennsylvania which covers 45,000 square miles.

6 Negotiations are going on now, but the topic is too sensitive for details to be disclosed.

7 Note that in Houston a CCTV system which includes a fiber communications backbone is being leased from a private sector service provider.

California Case Study: City of San Jose

I. Overview

The City of San Jose is working on a Traffic Signal Management Project (TSMP) and a Motorist Information Systems Project (MISP) as part of its ongoing efforts to deploy an Intelligent Transportation System (ITS). The deployment involves applications such as changeable message signs, closed circuit television (CCTV), and traffic light control. The system presently includes 9 CCTV cameras, 6 message signs, and a total of 200 intersections with communications capabilities. Over the next few weeks, 9 more cameras and 3 more message signs will come on-line. By June of 1996, 550 of San Jose's 650 intersections will be connected to the control system. Fiber was deployed by the City to separately interconnect each CCTV camera to the central traffic control center.

An ITS deployment options report was provided to the City Council by DKS Associates and the City of San Jose Department of Streets and Parks. The report was finalized in 1990, initial deployment began in 1991, and completion of the TSMP is anticipated in June 1996. Total funding for the ITS deployment is $26.8 million, of which $7.9 million is from the city and $18.9 million is from grants. The cost for the fiber component of the system is not available because of cost accounting difficulties involving the conduit which is shared for twisted pair (TP) and fiber infrastructure.

II. Description of the deployment under consideration

Construction of the communications system, as well as operations and maintenance is handled by the City of San Jose Department of Streets and Parks.

Twisted pair is being used for interconnecting traffic intersections which are equipped with 1200 BAUD dial-up modems. The communications at each intersection supports alarm monitoring and remote traffic signal adjustment.[1] Loop detectors measure traffic flow which allows for a schematic representation of the traffic flow at the traffic control center. About half of the TP lines are leased and the remaining are owned by the city.

Fiber is being installed to support full motion video with the intention of potentially developing segments of the system into a communications backbone. The system is FDDI compatible and may be upgraded to SONET if a backbone is installed. The system is configured using a hub topology with one fiber dedicated to each camera. At this time there are no multiplexers in the system, however, some single mode fiber was installed to support future upgrade ability. The city wholly owns and operates the fiber system.[2]

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1 An alarm indicates when a signaling device has failed.

2 A table was not included in this case study because most of the data is either not available or applicable.

III. Description of the key decision factors

The decision to deploy ITS in San Jose was made by the City Council with the advice of DKS Associates and the Department of Streets and Parks.[3] A feasibility study was prepared by the consultants which provided multiple options for ITS deployment.

System planning considered the total budget of the project with the simultaneous objectives of maximizing the total amount of city owned infrastructure and the overall capabilities of the ITS system. Owned infrastructure was considered superior because the Department of Streets and Parks wanted to avoid the uncertainty of leasing costs and felt that the city would be much more likely to prioritize maintenance than a private sector service provider.

The City Council was made aware that higher end ITS deployment options would require a larger funding commitment for operations and maintenance. The City Council agreed to provide necessary funding to support staffing requirements, but grant money obviated the need to request full funding from the city.

IV. Policy on leasing reserve capacity

At this time the city does not lease capacity because it is reserved for future ITS requirements. However, the City of San Jose Telecommunications Working Group, which is comprised of city management and directors, is developing a leasing policy.

At this time, private telecommunications service providers have not expressed any problems with the city's deployment of telecommunications infrastructure to support the TSMP.

V. Future developments and related projects

Originally plans called for a 50/50 mix of leased and owned twisted pair lines to support ITS needs. However, on average the leasing cost per line has doubled during the past 3 years. Consequently the city now plans to utilize owned infrastructure for 75% of the drops.[4]

Some problems with the Department's installation work have arisen due to a lack of familiarity with large scale systems implementation. However, staff expressed confidence that as their familiarity with the technology grows, system operations and maintenance should function smoothly. No major problems are anticipated.

A new water distribution system being built in San Jose to satisfy EPA regulations will require much of the city's right-of-way to be opened for construction. The city may

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3 It should be noted that there is a strong City Manager in San Jose that can influence the decision making process.

4 Even with price increases it would not be economical to deploy drops to 25% of the intersections.

use this opportunity, and its ability to leverage right-of-way, to develop a fiber optic backbone to support ITS. At this time there is considerable private sector interest in obtaining access to the right-of-way for fiber deployment.

Missouri Case Study: DTI Deployment

I. Overview

The Missouri Highway and Transportation Department (MHTD) is developing a statewide Intelligent Transportation System (ITS) to support the needs of metropolitan St. Louis and Kansas City, and rural Missouri. The state's goals for ITS deployment include increased vehicle speeds, improved air quality, reduced energy consumption, and improved safety. The services that will be made available are principally in the areas of rural and urban highway traffic management and traveler information. MHTD will utilize a fiber optic communications network to support new applications.

Planning reports and technical memoranda for ITS deployment in the St. Louis metropolitan area were prepared by Edwards and Kelcey, Inc.[1] The consultants made recommendations about the technical design and potential benefits of ITS deployment.

In exchange for access to the state's right-of-way, Digital Teleport Incorporated (DTI) is deploying fiber along 1,250 miles of state right-of-way, and will provide MHTD with 3 T1 (1.5 Mbps) lines at each of 300-400 network nodes throughout Missouri.[2] The state is responsible for all system components that it chooses to interconnect to the main fiber network which DTI will wholly own, operate, and maintain. The total cost to DTI for deployment is expected to be about $45 million. The state will pay nothing for system access.

II. Description of the deployment under consideration

According to technical memoranda prepared by Edwards and Kelcey, a fiber backbone was the only sensible option to support the communications needs of a regional ITS deployment. Planning documents note that of the various transmission media available, only coaxial cable, microwave, and fiber are capable of supporting broadband services. Planners quickly ruled out coax and microwave, noting that fiber is more reliable and can be upgraded to higher capacity, and that microwave is not particularly desirable because antennas at each site would be aesthetically unacceptable and would be difficult to locate since they must be in line of sight of one another.

In 1993 MHTD began exploring the possibility of leveraging its right-of-way to obtain communications capacity. Many private sector businesses expressed an interest in accessing the right-of-way. In the fall of 1993, 22 cable and telephone companies

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1 Technical Memoranda, Bi-state St. Louis Area IVHS Planning Study, Edwards and Kelcey Inc., 1993

Final Report, Bi-state St. Louis Area Intelligent Vehicle Highway System Planning Study, Edwards and Kelcey Inc., April 1994

2 The contract formally states that MHTD will receive 6 fibers but according to MHTD staff, DTI will provide T1 connections as described.

attended a pre-bid conference for a Request For Proposal (RFP) that the state was drafting to select an appropriate contractor. The RFP was for provision of fiber communications capacity throughout the St. Louis metropolitan region, but allowed bidders to propose broader deployments including Kansas City and rural portions of the state. Early in the spring of 1994 proposals were submitted and DTI was selected.

DTI will pull fiber along 1,250 miles of MHTD right-of-way including 200 miles in the St. Louis metropolitan area. However, DTI will be fully responsible for all operations and maintenance of the system which will provide the state with 3 T1 lines (1.5 Mbps each) at each of 300-400 interchanges throughout the state. MHTD will be responsible for building and maintaining all system components that it interconnects to each node and is confident that the system will provide sufficient communications capacity for ITS needs.[3] The total cost to DTI is estimated to be about $45 million state wide, including controllers, of which about $22 million will be spent on the communications system in the St. Louis metropolitan area.

DTI's network is based upon the Synchronous Optical Network (SONET) standard to ensure that systems operated by other agencies in the region can be interconnected.[4] The fiber network will be comprised of a main backbone with OC-12 capacity (622 Mbps). OC-1, OC-3, T3, and T1 streams can be multiplexed onto the system. DTI is using a Japanese company as the system vendor for the project.[5]

TABLE I - FINAL NETWORK CHARACTERISTICS

project	standard	vendor	capacity	fiber type	system length	total cost
Missouri	SONET	Japanese supplier	OC-12	SMF	1200 miles	$45 million

** "capacity" refers to the speed of the backbone*

** SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

** "system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

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3 The April 1994 Final Report states that "The type of media used for communication from the nodes to the field equipment can vary, depending upon the specific situation requirements. For instance, the media could be fiber optic, copper twisted wire pair, spread spectrum radio, microwave, or other appropriate technology. The media could even be the re-use of existing interconnect cable from an existing signal system. The recommended communications media for connection of field equipment is fiber optic cable."

4 This is particularly important for the St. Louis metropolitan area which includes both Missouri and Illinois.

5 There was some difficulty with obtaining the vendor name from DTI.

III. Description of the key decision factors

MHTD immediately began looking for alternatives to direct fiber network procurement when planning studies by Edwards and Kelcey reported that the cost for the fiber system in the St. Louis metropolitan area alone would be an estimated $22 million.

Planners noted that leasing costs were "astronomical" and that there was a fear that leasing costs would increase.[6] However, planners noted that it was generally believed that system reliability could best be ensured using a privately owned network because the state does not have the expertise to perform operations and maintenance. System reliability would be ensured because the private sector has a financial interest in system maintenance and reliability based upon the revenue potential of the network.

The MHTD decision to leverage right-of-way for communications capacity was in part spurred by the national interest in fiber optic network deployment at the time. Planners believed that the private sector was moving rapidly, and that the state should act quickly while there was substantial demand for access to the state's right-of-way.

Top management at MHTD, the State Highway Commission, and the US Department of Transportation (USDOT) approved the RFP described earlier. Approval from USDOT was required because ordinarily utilities are not allowed to access interstate right-of-way

IV. Policy on leasing reserve capacity

The contract with DTI grants exclusive rights and privileges which prevent the MHTD from providing preferential right-of-way access for alternative fiber optic deployments or utilizing the MHTD's capacity for non-ITS applications. The Missouri Public Services Commission refused to allow the state to obtain communications capacity under a more lenient arrangement for regulatory reasons.

V. Future developments and related projects

Work on the communications system will probably be completed one year ahead of schedule in 1997 because DTI is accelerating deployment to meet paying customer demand. At this time, the state is satisfied with the work being done by DTI. It should be noted, however, that the system is not yet operational.

Missouri's future ITS system will include components such as variable message signs, detector stations, ramp meters, and real-time video surveillance cameras as well as computers and workstations for a central traffic operations and information center. The estimated total cost of deployment of ITS in the St. Louis metropolitan region is expected to be about $95 million. Statewide costs are not yet available. Missouri's strategy is to deploy incrementally and build support for ITS with early successes.

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6 In an interview with a project worker, past increases in leasing costs for twisted pair were cited.

Legislation was proposed to build a state telecommunications network to serve the broader communications needs of the government.[7] MHTD briefly considered building a network to serve the government but soon rejected the idea because (1) of potential opposition by telecommunications companies, (2) the Public Services Commission's opposition to having an unregulated utility compete against a state regulated utility, and (3) the belief that waiting for sufficiently broad consensus to form for such an ambitious project might allow the brief window of opportunity to leverage state right-of-way to be missed.

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7 The exact status of the legislation has not been determined.

Case Study: New Jersey Highway Authority

I. Overview

The New Jersey Highway Authority operates the Garden State Parkway, a 173 mile toll road that runs north and south along the New Jersey coast. The Authority is deploying an Intelligent Transportation System (ITS) to improve the responsiveness and productivity of Parkway staff and to provide traveler information to motorists. There are several systems already in place and numerous additional concepts are being considered for future deployment. The Authority is faced with a rapidly growing dependence on communications to operate and manage the Parkway and has outgrown its existing microwave communication system backbone. The Authority plans to deploy a fiber optic network to meet its communications requirements.

Staff at the Authority projected future needs for device deployments in the northern half of the Parkway. Once the projections were established, the Authority approached vendors to solicit concept plans. The Authority hired Fredrick R. Harris, Inc. to develop the concept plans into a design.

The Authority is presently operating variable message signs and several miles of Parkway equipped with traffic monitoring devices such as loop and probe detectors. The Authority is planning to instrument a 27 mile stretch of the Parkway to provide automated monitoring and traveler information to motorists. Critical sections of the Parkway will be monitored using closed circuit television (CCTV) cameras. The Authority is also in the process of installing ice detection systems and plans to incorporate information kiosks and electronic toll and traffic management (ETTM) capabilities into future deployments. The ETTM system design includes a an enforcement capability which captures video images of the license plates of violators and then transmits this information to the GSP Woodbridge Headquarters for processing. In addition, the ETTM system must provide an "on-line" capability for establishing new accounts, closing accounts, and flagging invalid accounts at any Parkway toll collection point. Thus toll plazas and ramps need to have access to the central host computer at all times.

The Authority developed a two-phase plan to deploy a fiber optic communications system for its 173 mile roadway. The plan's initial phase is concentrated on the northern portion of the Parkway, where traffic congestion and incidents are the greatest. A follow-on phase provides for the communications needs of the southern portion. A Request for Proposal was issued to solicit innovative public-private cooperation in constructing and operating the northern portion of the network. A joint proposal from Bell Atlantic and AT&T was selected from among several received. However, these negotiations have been curtailed pending forthcoming New Jersey DOT policy guidelines for such arrangements.

II. Description of the deployment under consideration

The need for broadband communications capacity to support CCTV cameras and other traffic management equipment was a critical factor influencing the decision to deploy a fiber based network. The existing microwave network was considered too old and inflexible to support the communications needs of the system. Specifically, the microwave network could not be extended to important locations and spectrum allocation was a problem. Fiber optic appeared to the most versatile medium capable of meeting the communications needs of the Parkway.

Authority staff determined that the communications system would need to support 62 full motion CCTV cameras for traffic monitoring, 64 ice detection systems, 61 variable message signs, 171 traffic counting stations, 66 voice circuits, 28 point to point circuits, 8 FDDI LANs, and 28 Ethernet LANs running at 20 Mbps. The design produced by F.R. Harris, Inc., a consultant to the Authority, included a six (6) duct conduit distribution system to handle backbone fiber, distribution fiber, and copper plant.

The Authority wanted to develop a public-private partnership to construct and operate a fiber network. Meetings were held to discuss technical and business requirements with interested vendors. The Authority established evaluation criteria and a review committee to handle the bids and eventually selected a Bell Atlantic/AT&T joint bid to provide the communications system for the northern half of the roadway.

A SONET based fiber optic system was chosen by the Authority to ensure that the network could be integrated into fiber networks operated by others within the region. The backbone system proposed was based on AT&T with a speed of OC-12 (622 Mbps).

TABLE I - FINAL NETWORK CHARACTERISTICS

project	*standard*	*vendor*	*capacity*	*fiber type*	*system length*	*total cost*
NJ - GSP	SONET	AT&T	OC-12	SMF	40.5 miles	Pending
			OC-3		29.8 miles	

** "capacity" refers to the speed of the backbone, OC-12. In addition, the NJ-GSP plans include OC-3 communication levels for medium service distance terminals (MSDTs) which collect, multiplex and covert signals from copper wire segments for optical transmission. A copper wide distribution plant extends to ITS devices up to four miles away, on either side, of the MSDTs.*

** SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

** "system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

III. Description of key decision factors

The decision to install a fiber optic communications network along the Parkway right-of-way was based on several factors including (1) cost, (2) availability of services from private carriers, (3) bandwidth requirements, (4) flexibility to meet future needs, and (5) security and integrity of the medium. These factors lead the Authority to conclude that a private fiber optic system would economically and technically address its needs. The cost of leasing lines and the lack of existing service in some areas, compelled the Authority to pursue the development of a dedicated system. The Authority did, howver, seek out private providers to cooperatively develop the communications infrastructure it needs to meet its ITS requirements.

IV. Policy on leasing reserve capacity

To date, the New Jersey Highway Authority has not been in a position to consider leasing reserve communications capacity. However, the Authority has traditionally been open to new revenue opportunities, consistent with its overall charter.

The Authority, for instance, was approached several years ago by a major telecommunications service provider which wanted to obtain access to Parkway right-of-way for a transatlantic communications line. Negotiations resulted in the installation of conduit along 38 miles of roadway with one duct leased at a reduced rate to the carrier and remaining ducts successfully leased to other carriers. Since the initial installation, additional conduit sections were added bringing the total length of the conduit system to 76 miles.

V. Future development and related projects

The New Jersey DOT is working to structure an overall policy for developing ITS communications infrastructure through public-private cooperation. New Jersey Highway Authority interests and plans are being considered as part of this process.

The New Jersey Highway Authority plans to continue negotiations with Bell Atalantic and AT&T for the system. The Authority is confident that by working with Bell Altlantic and AT&T it will be able to achieve a fully redundant system that is able to meet its current and future needs. The Authority also consideres that the spare conduit space it will receive will be a very good revenue generator and/or a valuable resource for other state agencies that may wish to deploy fiber systems.

California Case Study: Bay Area Rapid Transit

I. Overview

Bay Area Rapid Transit (BART) operates a major rapid transit system in the San Francisco bay region and is presently deploying an Intelligent Transportation System (ITS) to service its customers through a joint development project with MFS Network Technologies (MFSNT). The deployment consists of two separate but related projects. First, MFSNT will build and maintain a conduit system in the BART owned right-of-way which will provide revenue to both BART and MFSNT. Second, MFSNT will deploy a new fiber optic and wireless telecommunications system which will be wholly owned and operated by the transit system, called the BART Telesystem. MFSNT and BART finalized the agreement December 1994.

The ITS system will eventually include high resolution video surveillance systems, video monitors to provide traveler information, train control and monitoring, and destination sign and announcement control. Many of these systems are already operational, however, applications such as video surveillance will not be available until broadband infrastructure is in place. The Telesystem will support all of the needs of BART, including communications for police and maintenance workers.

Kingston Cole Associates provided consulting advice for the joint conduit development and suggested that the conduit could pay for itself and provide enough revenue to pay for the BART Telesystem. The Telesystem was designed in-house by BART staff.

Conduit will be installed along 71 to 86 miles of track with space reserved for a sheath of 48 fiber strands dedicated to transportation applications. The total cost of the fiber system including controllers is about $7 million.

II. Description of the deployment under consideration

In the spring of 1993 a Request For Proposal (RFP) that provided several options for bidders was issued by BART. The first option was to bid on installing conduit in a joint development project with BART that would involve sharing profits from conduit tenants. The second option involved bidding on both the conduit joint development and the Telesystem as a package deal. The third option provided the opportunity to bid on obtaining right-of-way for cellular sites that would allow a cellular carrier to provide its customers service within the transit system.

MFSNT was selected in August 1994 as the top candidate because of their willingness to bid on both the conduit joint development and the Telesystem. The only other bidder willing to handle multiple portions of the project was a California based company called Info Systems Inc. However, the company was not considered as a serious contender because the size of the job was too large for the relatively small company.

The joint development for the conduit system provides for the installation and maintenance of a 4 inch conduit with an inner duct reserved for the exclusive use of

BART. MFSNT will market the remaining capacity to telecommunications service providers and will split the revenue with BART which will receive a 91% share.[1] MFSNT will invest about $3 million to build the conduit system.

MFSNT will build the Telesystem and provide training to BART employees who will then be responsible for operating and maintaining the system. The Telesystem includes both wireless and fiber technology which, along with offering versatility, provides system redundancy. Wireless will primarily be used for police and maintenance communications whereas the fiber will support applications such as video surveillance. Fiber was selected because it provides broadband capacity, security, and is not susceptible to electromagnetic interference.[2] The total cost of the BART Telesystem, including both fiber and wireless components, is about $44.6 million which is being financed by Pitney-Bowes Credit Corporation (PBCC).

The fiber network which will extend along 71 to 86 miles of track will cost about $7 million, including controllers. The technology vendor is AT&T. All the fiber being installed is single mode and will initially run at OC-3 speeds. The fiber optic cable will consist of 48 strands of fiber. Caltrans will receive control of 4 fibers for its Traffic Operations System (TOS) because some of the conduit will utilize right-of-way that is jointly controlled by Caltrans and BART.

TABLE I - FINAL NETWORK CHARACTERISTICS

project	*standard*	*vendor*	*capacity*	*fiber type*	*system length*	*total cost*
BART	SONET	AT&T	OC-3	SMF	71-86 miles	$7 million

* *"capacity" refers to the speed of the backbone*

* *SMF represents "single mode fiber," MMF "multimode fiber," and mixed corresponds to both.*

* *"system length" refers to the number of miles of transportation infrastructure serviced by the deployment*

III. Description of the key decision factors

The decision to procure a fiber network was made primarily within BART although Caltrans was also involved because some right-of-way where conduit is being installed is shared.

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1 MFSNT will own the conduit during the license agreement. After 15 years, if MFSNT decides not to continue the arrangement, the conduit will be sold to BART for $1. MFSNT is responsible for operations and maintenance of the conduit unless ownership of the conduit transfers to BART.

2 Presently a T1 carrier is being used to support some of BART's telecommunications needs. However, T1 capacity is insufficient to support broadband applications.

It was felt that the Telesystem should be wholly owned and operated by BART in part because relying upon a third party in an emergency was considered highly undesirable. A strong belief was expressed that for the health, safety and welfare of the transit system, leasing capacity would be undesirable. There was a strong interest in maintaining full control of the system and it was described as the "philosophy" of BART to do so. It was also noted that the transit system has unique needs that are not comparable to fiber deployments to support highway oriented ITS applications because much of the system is subsurface and includes unique operations such as vehicle control.

The BART Telesystem is also an expensive project. It was noted that without a large amount of available funding, the joint development approach was the only feasible option for system development. Public agencies are undergoing financial pressures which cannot be alleviated by raising taxes. The arrangement with MFSNT was considered highly compelling because it may create revenue for BART which, according to the cost analysis performed by Kingston Cole Associates, will cover the debt incurred by the project and provide excess revenue. At this time the exact revenue potential is uncertain because leasing arrangements will be negotiated on an ad hoc basis.

Leasing capacity from a private company to provide system redundancy was considered, however, the provider would have required access to the right-of-way controlled by BART which seemed inappropriate because BART would then be effectively paying a private company to use its right-of-way rather than leveraging the right-of-way to make a profit.[3]

IV. Policy on leasing reserve capacity

The Telesystem is dedicated for the needs of BART and does not provide for any reserve capacity for third parties. There was some consideration of building and owning a telecommunications system that could offer leased capacity, however, this would have required certification of BART as a public utility which was deemed undesirable. The Telesystem is expected to have enough reserve capacity to satisfy the transit system's communications needs for the next 20 years.

V. Future developments and related projects

BART and MFS are presently looking to establish a first tenant for the conduit system. A Fortune 500 company has signed a contract with MFSNT, however, the details have not been made public because BART has yet to sign the agreement.

At this time there have not been any problems with the work done by MFSNT. It was noted that if there are problems with the project it will not be with the joint development but rather with the Telesystem because integrating the wireless and fiber communications technology will be challenging.

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3 The BART Telesystem includes a redundant fiber network. The wireless system also provides for redundancy.

Shared Resource Opportunities and Impediments

Shared Resources Research Project
Briefing for April 27, 1995 Forum

As private telecommunications companies seek space to extend fiber optics networks, and government agencies seek to establish communications networks for ITS and other governmental functions, there should be increased opportunity for sharing the public resource of highway right-of-way and private resource of telecommunications expertise to further both public sector and private corporate objectives.

With that in mind, FHWA authorized the Shared Resources Study to identify, analyze, and document the nontechnical issues (legal and institutional issues) related to such shared resource projects, and to develop and present guidance for those considering the shared resource approach in highway rights-of-way.

Although the concept and many of the issues also apply to other public resources, the term "shared resource project" as used in this study refers specifically to public-private sharing of highway rights-of-way, previously viewed as entirely within the public domain. Moreover, as understood by most of the transportation professionals who participated in this study, a shared resource project involves (a) installation of telecommunications hardware (principally fiber optic lines but also including cellular towers) and also (b) some sort of compensation (over and above the administrative costs) that is granted to the public sector authority in consideration for private access to the public right-of-way or communications facilities.

The following presents a list of the issues identified by the study research team, including some representative questions incorporated under each issue heading.

Legal and Political Issues

1. Authority to Use Public ROW for Telecommunications

Does the public sector have the authority to use transportation right-of-way for non-highway and non-transportation functions? Does the public sector have the authority to grant private firms longitudinal access to public right-of-way? Does the public sector have the authority to prohibit or put conditions on private sector longitudinal access to right-of-way?

2. Authority to Participate in Public-Private Partnerships

Does the public agency have the authority to participate in public-private partnerships? Are special statutes or legislation required? Is authority limited to transportation-only ventures?

3. **Public Sector Authority to Receive and/or Earmark Compensation Received**

Is the public sector allowed to receive compensation for private access to the public right-of-way over and above administrative costs? If so, can the public sector earmark these revenues for transportation or other designated uses?

4. **Political Opposition from Private Sector Competitors**

Will private sector communications firms oppose public sector self-supply of ITS communications needs? Will private sector communications firms oppose public sector self-supply of other communications needs (bypass networks)? Will public agency sale/lease of its excess communications capacity (capacity on a public sector communications system) be considered "unfair competition" by private sector providers?

5. **Inter-Agency and Political Coordination**

Are there political/administrative constraints to multi-agency coordination within the same political jurisdiction? In neighboring jurisdictions?

6. **Private Sector Interest in Shared Resources**

Regardless of the public sector interest in shared resources projects, are the benefits to the private sector sufficient to overcome any disincentives to participation?

Financial Issues

7. **Valuation of Public Resources**

What is the appropriate method for evaluating the monetary value of access to the public right-of-way? How should the public agency determine what is fair compensation for longitudinal access in specific cases?

8. **Valuation of Private Resources**

What is the appropriate way to determine the value of privately-provided communications infrastructure and/or communications services provided to the public sector as part of a shared resources project?

9. **Public Sector Support Costs**

How much does it cost the public sector for negotiation, management, and oversight of shared resources projects?

10. Tax Implications of Shared Resources Projects

Does public agency receipt of compensation from shared resources projects (in kind and/or monetary) generate a federal income tax liability? Do such revenues threaten the tax-exempt status of bonds issued for the project?

Project Structure Issues

11. Form of Real Property Right

What is the resource to be shared -- the right-of-way itself or excess communications capacity in a publicly-installed and operated network that is leased to the private sector? Under what structure can private partners access or use the public right-of-way? Who will own and maintain the communications facilities once installed?

12. Type of Consideration

Does the public agency prefer monetary compensation (lease payments, etc.), in-kind services (barter or a "public service" contribution), or a combination of both, in exchange for the right to use the public right-of-way or public communications infrastructure?

13. Exclusivity

Should/must shared resource projects be open to all qualified parties interested in gaining access to the right-of-way and/or public communications capacity? Can/should a single private partner be selected to participate in a shared resource project? How should potential partners be screened?

14. Procurement Issues

What process is used to select private sector participants? Are competitive bids mandatory for legal or political reasons? What criteria are used to screen bidders? Is the public sector agency free to negotiate or bargain over terms? How are subsequent bids for access treated after the initial project has been arranged?

Other (Contract) Issues

15. Relocation

Who is responsible for paying the cost and managing relocation of infrastructure constructed in the public right-of-way if and when transportation improvements require relocation?

16. System Modification

Who is responsible for providing updates and modifications to the publicly-dedicated communications infrastructure originally installed by the private partner? Can the public sector bind vendors to maintain public sector equity with private partner technological improvements on an open-ended basis? Can the public sector include future expansions as part of the contractually arranged compensation? What is the effect of vaguely-defined future obligations on private sector willingness to participate?

17. Most-Favored Community Issues

How can communities be assured that they receive treatment equivalent to that received by other communities involved in shared resources projects?

18. Geographic and Social Equity

Must the transportation agency provide other public agencies with communications capacity and/or revenues from shared resource projects? Are public agencies and private partners required to distribute communications capacity and/or the benefits of shared resources projects evenly among groups within the general population? Does the public agency have the authority/obligation to require private sector installation of communications infrastructure to areas that generate social but not revenue benefits?

20. Liability

Who is legally liable for the effects of system malfunctions, accidents due to right-of-way work on the communications infrastructure, and breach of warranty?

21. Intellectual Property Issues

Who has the rights to intellectual property involved in a shared resources partnership? On what basis can distinctions be made between property in the public sector domain and that which is private partner property?

Wiring Massachusetts

An Agenda for Public / Private Cooperation to Facilitate Deployment of Telecommunication Systems Along Massachusetts Highways

Commonwealth of Massachusetts

Executive Office of Transportation and Construction
Massachusetts Highway Department

William F. Weld
Governor

Argeo Paul Cellucci
Lieutenant Governor

James J. Kerasiotes
Secretary

Laurinda T. Bedingfield
Commissioner

Introduction

It has become virtually impossible to look at any news source without seeing a reference to the Information Superhighway, the Internet[1], or the National Information Infrastructure[2] (NII). The Massachusetts Highway Department (MHD) is offering to assist the telecommunications industry in providing Right-of-Way access adjacent to the state highway system for the deployment of advanced telecommunications systems and to foster the NII. In the end, it is our hope that for the first time, all the district telecommunications conveyance providers (telephone, cable television, wireless, cellular) will work together to not only address the communications infrastructure needs of today, but to address the future needs for high speed data conveyance and delivery systems.

In this effort, the MHD is working to build a consortium of telecommunications carriers to develop a telecommunications delivery system that will collectively benefit industry, government, and consumers and be in keeping with the desire to produce the most technologically advanced system in the nation.

The telecommunications industry is experiencing tremendous growth and opportunity. The breakup of AT&T a short decade ago was only the beginning of this trend. The eventual passage of federal legislation allowing cross market competition (long distance, local telephone and cable television) has hastened competition in the telecommunications industry. The potential market and economic impacts attributable to these events are tremendous. There are many questions that need to be resolved, but invariably the central concern for both service providers and consumers alike is infrastructure.

Can the systems of today provide for the services being developed for tomorrow? For all providers the answer is dependant on the demand for new services, such as internet commerce, video on demand, personal video teleconferencing, simultaneous voice, video and data transmission, etc. The short answer is no, all systems must evolve and grow. For the local telephone company, the current state of their infrastructure is limited band width for video and low speed for data transmission. Cable companies, numbering more than twenty in Massachusetts, have problems with connectivity (interconnecting the local cable networks

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[1]The Internet came into existence in the late 1960's as 'DARPA' (Defense Advanced Research Projects Agency), a network designed to facilitate the transfer of mission-critical design and development data for the Department of Defense. Currently, this network is referred to as the Internet and was opened for commercial applications in early 1994, creating many business opportunities for Massachusetts companies such as Delphi Internet Services, an Internet access provider, and Internet Commerce and Communications, a consulting firm providing services in the vast markets created by the opening of the Internet.

[2]The National Information Infrastructure (NII) is generally defined as a high speed, high capacity dataway connecting all metropolitan and commercial centers in the United States for simultaneous data, video, and voice transmissions.

The aim of *Wiring Massachusetts* is to join cooperatively with the telecommunications industry to lower the overall deployment cost for commercial telecommunications development and, at the same time, improve the MHD's ability to operate the Commonwealth's highway system. To that end, we are committed to the following objectives:

- ✓ To help the telecommunication carriers penetrate new markets in Massachusetts and improve service capacity with telecommunications equipment locations throughout the Commonwealth;
- ✓ To accommodate on an equal basis all telecommunications carriers who are willing to participate in the network development costs;
- ✓ To enhance the competitive position of all telecommunications carriers in Massachusetts;
- ✓ To work cooperatively with the industry to provide all available expertise to facilitate the design and development process;
- ✓ To enhance the MHD's Intelligent Transportation System at no direct cost to the taxpayers.

By providing easier access to the Massachusetts market, our belief is that we will help ensure the advancement of all telecommunications systems throughout the Commonwealth. It is understood that in time, with the existence of an advanced telecommunications infrastructure, many direct and indirect dividends will be paid to the Commonwealth, and the impact on our economy will be enormous.

Thomas F. Dengenis
Associate Commissioner

together and then connecting to the long distance carriers) and switching (the ability to handle many users or callers at the same time). For the wireless sector, the networks are just starting to grow.

All of these transmission problems are being solved today. Nevertheless, one problem confronts all network developments: getting to the market (Right-of-Way access). The MHD owns and controls important Right-of-Way and is able to facilitate all necessary accommodations under law. It is our aim to provide the Right-of-Way to achieve:

- ✓ rapid market penetration;
- ✓ competition in the delivery of services;
- ✓ simultaneous improvements in the commercial and government telecommunications infrastructure.

The MHD, being one of the largest land owners in the Commonwealth, has historically restricted its property uses to highway operations. In 1988 the Department broke away from its "no access" position and adopted a policy that accommodates lateral crossings of utilities within limited access highways. In 1992 the MHD expanded that policy to include longitudinal utility accommodations. Since these policy changes were adopted, applications for longitudinal access have only occurred twice: (1) a high pressure sewer line along Interstate 93 in Reading, (2) and a fiber optic cable along interstate 95 in Weston. This small number of applications is striking when compared to the enormous rise in activity of the telecommunications industry since 1992 and its new system deployments throughout the Commonwealth. In our quest to understand why these applications were so few, we learned that the revised policy was not widely known by the industry. Secondly, once known, concerns grew with how to provide access to one carrier without damaging future access for others. Our answer to that concern among others is being presented by the MHD through this policy initiative entitled *Wiring Massachusetts*.

Wiring Massachusetts is designed to provide an agenda for public/private cooperation to facilitate deployment of telecommunication systems along Massachusetts highways. To ensure mutual benefit for the Commonwealth and the greatest participation of the telecommunication industry, the strategic elements to this policy provide for an organized, inclusive, and *quid pro quo* approach to accessing our highway system. The *quid pro quo* is designed to enhance the MHD's highway operations and as well, limit our financial impact on the commercial project. For instance, a fiber optic deployment along Interstate 95 would require the installation of additional conduit components to be reserved for MHD's Intelligent Transportation Systems[3] along that route.

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[3]Intelligent Transportation Systems' (ITS) principal objective is to use advanced telecommunications and computer technology to operate the highway system. Operational objectives include congestion management, emergency incident management, weather condition management, and advanced traveller information services (such as *SmarTraveler*, a public/private partnership between SmartRoute Systems, Inc. and the Massachusetts Highway Department).

Framework for Public / Private Cooperation

As indicated in the introduction, the MHD is providing the framework to facilitate telecommunications infrastructure development through the shared use of public and private resources. The resources to be shared consist of public property and private expertise and investment. The actions to be taken by the telecommunication carriers and the MHD will facilitate the timely deployment of telecommunications systems and allow for the planned development of telecommunications facilities within Massachusetts to benefit the economy. The following will highlight specific parameters that are key components of this initiative.

✓ *Protecting the Private Investment*

We recognize that it becomes vital to the success of this initiative to protect private investment wherever possible. Therefore, it is our commitment to provide a permit that is not renewable, nor revocable at will by the MHD. The MHD will provide a continuing permit which can be terminated by the MHD only if the Lead Company breaches the Lead Company Agreement, the property is needed, in whole or part, for highway purposes or is taken by superseding eminent domain, or is made unusable by a government order.

While the system is being developed, the MHD will inspect the area with a representative of the Lead Company from time to time throughout the design, construction, and maintenance phases. The MHD retains the right, upon inspection or determination that a condition hazardous to public health and safety exists as a result of the network construction, to order such additional work or modifications as may be required to correct any such defect or condition. Any increased fee, deposit, or additional cost incurred shall be deemed a shared cost for which Lead Company and Participants shall be equally responsible.

It is important to recognize that although a development may have many Participants, once construction has begun on any systems it is the sole responsibility of the Lead Company to finish the project. To acknowledge this important responsibility, the MHD shall not issue any permits to Participants until there exists sufficient evidence that the Participant has fulfilled its financial obligations to the project.

✓ *Providing Non-Exclusive Access*

Generally, the first responsible applicant for access will be designated the "Lead Company" and will have the overall operational responsibility for the permitting, installation, and maintenance of a new system at the requested location. The MHD will communicate only with the Lead Company concerning all aspects of a development and future maintenance of the state highway system in that location no matter how many other firms occupy that location. It is expected that each Lead Company Designation will exist for up to twenty four (24) months. This designation shall expire if the Lead Company is unsuccessful in obtaining the required permits to construct the facility. The MHD reserves the right to designate a Lead Company and to terminate the designation of a Lead Company, prior to entering into Lead Company Agreement, if necessary for the furtherance of this initiative.

To further the non-exclusive provision and enhance competition among providers, the highway Right-of-Way is initially open to any and all applicants and Participants at the outset and where physically possible. However, after the initial deployment is established as defined by this policy, future applications will be directed to the opposite side of the highway or on adjacent Commonwealth property. Once deployments are completed on both sides of the highway and on adjoining property, further applications will be considered special cases and shall be reviewed outside of this framework.

✓ ***Requiring Rapid System Deployment***

From the outset it is our intention to facilitate deployment activity. Therefore, once the MHD has issued a Permit and the local authorities have issued all applicable permits, the Lead Company must begin construction within ninety (90) days, unless there is a conflict with the MHD's policies prohibiting winter and holiday season construction; otherwise, the designation or permit shall expire and become void.

✓ ***Standardizing MHD Procedures and Agreements***

This initiative formalizes our desire to facilitate telecommunications infrastructure improvements through a process which minimizes development delays. Therefore, standard agreements, technical guidelines, review and permitting procedures designed to eliminate variation and uncertainty on either side, are utilized. Once the Lead Company and Participants understand the agreements, design parameters, and permitting processes, the deployment of systems can begin expeditiously.

The Lead Company and all Participants in the network will abide by MHD rules, standards, regulations and practices (especially the requirements relating to highway resurfacing and reconstruction) at their own expense.

✓ ***Defining the Quid Pro Quo***

It is vital to this initiative that we share resources to minimize expenses and maximize benefits. To that end, the MHD will charge no fee and will not be able to renew permits. In exchange for the rights to the highway Right-of-Way and other property, the MHD will receive system capacity.

For optical fiber conduit systems, the MHD will receive exclusive use of the "Commonwealth Component", defined as, three 1½ inch diameter conduits, lateral branching, manholes and handholes where ever a participant requires the same, and lateral branching for the MHD's Intelligent Transportation System equipment. For tower facilities, the MHD will receive exclusive use of reserved tower space including all tower connections and structural support and electrical power supply required for the Commonwealth's equipment. The Commonwealth Component shall be deemed to be a shared cost among all participants in the Telecommunications Facility and shall be constructed and maintained by the Lead Company. Thereafter, and upon completion of construction, title to all improvements on the premises shall vest in the Commonwealth, excluding any participant's Personal Property. As this initiative currently anticipates optical fiber cable and wireless tower facilities, other Telecommunication Facilities will require separate negotiation.

✓ *Defining Consortium Activities and Benefits*

This initiative relies heavily on cooperation among many parties: the MHD, the Lead Company and all Participants. To foster this cooperation, and to facilitate communication among key parties, the MHD will establish a Consortium, composed of all interested Participants. Interested parties in the telecommunications field may elect to become a member of the Consortium. On an ongoing basis, the MHD will automatically and directly provide each Consortium member with applicable public notices, maps, property inventories, general correspondence, policy modifications, and Lead Company Designations. All required public notice by the Lead Company will also be provided directly and automatically to all Consortium members.

THE STATES SWING INTO I-WAY CONSTRUCTION

More than a dozen are building local fiber-optic networks

This past spring, a group of eighth-graders in Mount Ayr, Iowa, were comparing the benefits of manned vs. unmanned space flight. They wanted to pick the brain of a nearby legend: astrophysicist James Van Allen, a professor emeritus at the University of Iowa at Iowa City. But the 80-year-old Van Allen, who discovered the radiation belt around the earth that bears his name, wasn't up to making the 200-mile trek to the tiny farm town.

So Mount Ayr turned to a simpler solution: Iowa's state-owned $100 million fiber-optic network, which connects hundreds of schools, hospitals, and public offices. Van Allen ambled down to a videoconferencing room at the university that is linked to a similar room at Mount Ayr High School. The one-hour interview session cost the school $10, compared with $500 for a commercial hookup.

"GREAT LABS." Iowa's glitzy Information Highway system is one that other states view with great envy—and fear. Governors worry that to attract industry and jobs, they must begin building similar state-of-the-art communications infrastructures. So legislatures are pouring millions of dollars into new high-capacity, intragovernment networks, often designed and run by local telephone companies.

These systems, which carry voice, video, and data, are meant simultaneously to improve state services and save money (table). According to a National Governors' Assn. report issued in July, more than a dozen states have Information Superhighway projects under way. "The states are all elbowing each other out of the way to be in the lead," says one New York State official.

The efforts are getting kudos, and funding, from Washington. "The states are great laboratories for us," says Robert M. Pepper, chief of the Federal Communications Commission's Office of Plans & Policy. But they also are getting a fair amount of static. Some legislators grouse about the tens of millions of dollars these systems can cost. And experts wonder whether the networks can deliver on their promise of economic development. While "these projects can be helpful, it gets overplayed," says Eli M. Noam, a Columbia University economics professor.

The skepticism isn't stopping states from plunging ahead with their plans. Iowa's system, which went on-line in November, 1993, is the first and also the largest. Planning for the project, built by Omaha-based MFS Network Technologies Corp., started during the farm crisis in the mid-1980s, when rural communities were going bust. The original aim was to link all of Iowa's public schools, providing them with access to universities and to professors such as Van Allen.

BIG-HOUSE CALLS. The hope was that a better-educated workforce could vie for new industry with areas boasting better school systems. "We wanted companies to locate in rural areas, so the schools there needed the opportunity to compete," says Governor Terry E. Branstad. The jury is still out on whether the network will lead to jobs.

But Iowa is not stopping at education. The state is linking all of its armories with the help of a $10 million grant from the Pentagon. And $20 million from the federal Health & Human Services Dept., is helping hospitals to purchase equipment for video linkups between doctors in distant locations.

Other states are starting out small with their network-building, setting up pilot projects that are aimed at improving education or health care. North Carolina is using a video link to slash medical costs for its inmates at Central Prison in Raleigh. Doctors at East Carolina University Medical School in Greenville—more than 100 miles away—can monitor a prisoner's heartbeat as a nurse uses a digital stethoscope. The cost of such video consultations is $70, compared with $750 the state used to pay to transport patients and their guards to Greenville. Since the program started in 1990, the state has saved $211,000 on treatment, while spending only $100,000 on the network. "This is not just a sexy thing to do," says Lowell

INTRASTATE PROJECTS ON THE INFORMATION SUPERHIGHWAY

DALI GILLETTE

IOWA has the first state network up and running—and the largest (above: the Stark Armory Switching Center)

GEORGIA started up a statewide fiber-optic network in January that links colleges, grade schools, and technical schools

KENTUCKY will issue a contract this fall to develop a communications system to replace the jumble of government networks

LOUISIANA last year launched TeleMed, a program to provide a video linkup between urban hospitals and those in rural areas

SOUTH CAROLINA developed an extensive backup communications network in 1989, after Hurricane Hugo wiped out coastal service

TEXAS is setting up computer kiosks in public spaces to better distribute information about state services

DATA: NATIONAL GOVERNORS' ASSN.

Christy, a researcher at the hospital. "There are real economic benefits."

Which doesn't mean these projects enjoy clear sailing. In Iowa, Branstad ignited a political firestorm in 1991 when he announced that the network would be competitively bid rather than handed to local phone companies. "It was a very emotional battle," says Robert Eide of MFS, the low bidder.

"DOUBLE WHAMMY." The telephone companies tried to kill the project, arguing that the state had no business owning a network. They also warned that if the state shifted its $7 million in yearly phone traffic to a private operator, rates for other customers would soar. "This is a double whammy for taxpayers," complains Todd Schulz, state director of the Iowa Telephone Assn., which represents local phone companies. "Not only do they have to pay to build it, but they may have to pay higher phone rates, too." In fact, rates have not gone up since the network began operations, but Schulz still insists that hikes are inevitable.

To avoid similar flak, many states are working with their local phone companies. But without competitive bidding, costs can be inflated. That presents other roadblocks, as Maryland Governor William Donald Schaefer found. Last summer, he made a deal with Bell Atlantic Corp. to wire most of the state's schools with videoconferencing equipment so students can watch teachers in distant classrooms. But local cable companies protested to the state attorney general that the contract, which could be worth more than $50 million over 10 years, was issued without opening up the biddingprocess to competition. The state opened the contract to competition but required any bidder to provide switching service—which only the phone company could do. To no one's surprise, Bell Atlantic was the sole bidder. Outraged cable companies have filed a protest.

Most state projects are faring better. But those who think they'll be part of a seamless national information interstate may be disappointed. These networks are more likely to remain high-tech local roads. "There is no coordination" between the states, says Harry M. Trebing, a Michigan State University economics professor. "I'm not sure that's an optimal way to develop a network."

Governors, though, aren't too worried about the big picture. If they can improve services, save money, and create a few jobs, the funds for paving these high-tech roads will seem well spent.

By Mark Lewyn in Washington, with bureau reports