CHAPTER 2

Interagency Sharing

Of Fiber Optic Systems

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1. INTRODUCTION

Interagency fiber optic sharing is closely linked to the previous chapter on Inter-Jurisdictional Coordination For Traffic Management. One of the most important features of a Traffic Management Center (TMC) is the communications network which links cameras, variable message signs, ramp meters, advanced signal control systems, and other real time travel information to one or more TMCs. The communications system "puts the intelligence in an intelligent transportation system." There are a variety of wireline and wireless media available for performing the responsibilities of the communications network; copper twisted-pair, coaxial cable, digital microwave, digital pocket radio, cellular and fiber systems. All have advantages and disadvantages. Fiber-based communications networks, however, provide high bandwidth and high data-transmission rates and for these reasons are increasingly being used in the establishment of ITS.

The private sector use of fiber optics systems for a variety of purposes has been well documented. State and local agencies have a long history of franchising or accommodating fiber optic systems on public or private rights-of-way.

Other public agencies, state and local, also have a need for high-speed, high bandwidth communications to carry out their mission and to satisfy the growing public need to communicate with the public and private industry through the electronic media.

The combination of these three areas of need for fiber optics systems (ITS, private sector and other governmental agencies) has created opportunities for large cities to enter into multi-agency sharing arrangements for installation and use of fiber optic systems. While other types of sharing arrangements have received considerable attention,[1] relatively little has been written about fiber sharing among public agencies in large cities. What approaches have been successful? How can large cities best take advantage of opportunities for fiber optic sharing?

[1] One focus has been on public-private sharing of highway rights-of-way. See American Association of State Highway and Transportation Officials, *Guidance on Sharing of Freeway and Highway Rights-of-Way for Telecommunications*, 1996; and ITS America, *Shared Resource Projects: An Action Guide,* 1997.

2. ISSUES

The institutional issues regarding the sharing of fiber optic systems can be separated into four basic issues. These issues and the different approaches taken by various cities are outlined in this section.

1. What agencies are involved in fiber optic sharing arrangements; whether sharing arrangements span distinct missions or all relate to transportation activities.

In many instances fiber optic sharing takes place among transportation agencies that need to communicate to accomplish their missions. Fiber optic sharing is an extension of traffic management coordination, as discussed in the first chapter, and typically developed as part of an ITS project or program. Fiber sharing benefits the mission of each agency not only in terms of increased communications capacity, but also increased sharing of information among the participants and greater operational coordination.

Another approach is for fiber sharing to take place among agencies with diverse missions—e.g., transportation, schools, welfare agencies, etc. The benefit to agencies is primarily, if not entirely, in increased communications capacity and/or reduced communications costs from shared facilities. Fiber sharing in these instances does not typically bring greater coordination in the operations of the member agencies.

Finally, cities may build fiber optic telecommunications systems primarily to attract business and develop high technology employment.[2]

2. Type of relationship(s) between agencies.

Relationships can be more formal or less formal. Agencies may negotiate and sign formal memorandums of understanding specifying what is to be shared and responsibilities of each party. MOUs may be negotiated bilaterally or among several agencies. In some cases, MOUs have created a "virtual" agency that serves as the vehicle to coordinate construction, cost sharing and decision-making among the member agencies.

Conversely, staff from participating agencies may share fiber capacity without completing formal interagency agreements. For example, two transportation agencies may exchange access to fiber optic systems in order to share access to video camera feeds and other data.

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[2] There has been much attention to the importance of telecommunications and high tech to city economic development. See United States Council of Mayors, *America's Cities and the New Economy*, June 2000. Bloomington, Indiana is an example of a city building telecommunications capacity to attract business. See Jill Rosen, *Bloomington lays 'digital underground,'* civic.com, May 12, 2000.

3. Methods used to build the fiber optic system.

There is a range of options, from building fiber optic systems based on a comprehensive plan to phased or incremental approaches. The differences relate to the type of planning conducted, sources of funding and timetable for construction.

Comprehensive approaches involve a greater degree of upfront planning, identification of funding and more expeditious construction. Comprehensive ITS projects that include fiber optic construction are a prime example of this approach. Multi-purpose, multi-agency systems are a second example of the approach.

Incremental approaches take a number of forms. Many cities have obtained conduit capacity under city streets through requirements that telecommunications companies provide capacity to the city when digging in the city right of way. Transportation agencies (city and state) have obtained fiber capacity by including conduit construction as part of highway, bridge and transit construction/reconstruction projects.

4. What is shared.

Another core issue involves what to share when sharing fiber optic networks. Fiber optic sharing arrangements can encompass any number of the following:

Sharing of physical facilities

Fiber optics systems either run though conduits underground or are suspended above the street on poles. Sharing arrangements include sharing conduit space, sharing fibers in a multi-fiber cable or sharing pole space. In addition there is the possibility of sharing the same fiber strand using wavelength division multiplexing (WDM). As the private sector is encountering capacity problems on their fiber optics systems, WDM is employed to multiply the potential capacity of each fiber by filling it with many wavelengths of light, each capable of carrying a separate signal. Carrying 16 wavelengths per fiber has become routine and the literature talks about up to 128 wavelengths per fiber.

Sharing of software

Agencies are finding that adopting the same software packages for transmitting information between agencies facilitates the exchange of information. Some areas have developed software that will “convert” information from one TMC into compatible formats for reception and use by other TMCs. However, when starting a new system of sharing, the development of common software that can be used by all participating agencies can be preferable provided that it can be done consistent with agency procurement procedures. Common software can also be employed to manage and troubleshoot the fiber system.

Sharing of expertise

Telecommunications systems can be very complicated in technical terms; all agencies participating in a sharing arrangement cannot be expected to have telecommunications

specialists on staff. Successful sharing arrangements have each agency sharing their unique expertise, be it technical, purchasing, maintenance, construction, etc.

Sharing of operations and maintenance responsibilities

For a shared telecommunications system to operate for all parties, there must be an arrangement for operating and maintaining the entire system over a long period of time. These responsibilities can be shared through a central city agency or through a "virtual" agency created by a memorandum of understanding involving a myriad of city, state and other entities. Alternatively, responsibilities can remain with the agency that owns each part of the fiber system.

Some agencies have a more "mission critical" need for real time information. Therefore, shared operations and maintenance must take into consideration individual agency needs.

Sharing of costs and financing

Fiber optics systems are not cheap. Installing fiber optics systems through franchising agreements and as parts of larger construction projects are ways to reduce the cost of the ultimate fiber system. Multi-agency sharing in the cost of implementing critical links reduces the individual agency cost.

3. FIBER OPTIC CASE STUDY FINDINGS

CASE STUDY CITIES

Information on the experiences of seven cities was gathered to gain an understanding of the range of approaches to fiber optic sharing. The project team visited Portland, Oregon, which has a particularly extensive fiber-sharing program. The project team also explored fiber-sharing arrangements during site visits to New York City and Houston that also looked at traffic management coordination. In the other cities key staff were contacted for telephone interviews and to obtain written materials.

Fiber-sharing arrangements in these cities can be classified into two categories:

- Sharing arrangements dedicated to transportation purposes as part of an ITS program;
- Multipurpose sharing arrangements among transportation and non-transportation agencies. Most often this is combined with separate (though interconnected) fiber systems devoted to transportation uses.

ITS Fiber Sharing

In Houston and San Jose, transportation agencies have developed sharing arrangements in conjunction with the implementation of regionwide Intelligent Transportation Systems (ITS).

Houston is developing a backbone communications system using components of facilities from each major agency included in TranStar. The sharing arrangement is basically sharing of physical systems, x fibers for you, y fibers for me. The participants are evaluating the use of wavelength division multiplexing to overcome some capacity issues.

San Jose. The fiber optic network was developed as part of the Silicon Valley ITS project using federal Smart Corridor funding.

Multipurpose and/or ITS Fiber Sharing

Portland, Oregon. Transportation agencies began the sharing arrangements while implementing the ITS infrastructure for the region. The City of Portland was attempting to link all city agencies with a high-capacity communications system. The result is a multi-purpose, multi-agency sharing arrangement that uses all five types of sharing arrangements (physical, software, expertise, O&M and costs).

Austin, Texas. Like Portland, Austin has taken both ITS and non-ITS approaches. Seven governmental entities including city, county and state agencies and the local school district have formed a consortium, the Greater Austin Area Telecommunications Network (GAATN), that connects 275 sites throughout the Austin area. In addition, City and State DOTs have or are building fiber optic systems for transportation purposes.

New York City. The agencies in the New York area are in the early stages of sharing fiber optics systems to facilitate the exchange of information and to reduce the cost of the overall ITS communications system. The city also has an essentially separate network for multipurpose, multi-agency sharing.

Denver. The local and state transportation and transit agencies have developed sharing arrangements to link management centers and field equipment. While this system is primarily targeted to transportation purposes, it also involves access for non-transportation agencies such as Police and Fire and various city/county buildings

Boston's "shadow conduit" program requires that telecommunications and electronics firms install conduit for City use whenever they dig beneath streets for their own purposes. Private companies must not only provide the conduit; they must also maintain it. Fiber optic cable that will be installed in this conduit will be used by a variety of City agencies.

Table 2 summarizes the characteristics of fiber-sharing activities in each of these cities.

LESSONS LEARNED

Sharing can involve at least five types of arrangements: physical facilities, software, expertise, O&M and costs. There are examples of successful arrangements in each of these categories.

A key lesson from the cities examined is that successful sharing arrangements can take a variety of forms and that "more" sharing is not necessarily "better."

Relatively "loose" sharing arrangements in which transportation agencies interconnect their fiber optic networks to share data while each agency builds, operates and maintains its own fiber facilities have worked quite well. Examples of this are found in New York, Austin, Houston and Denver. These arrangements tend to involve only two or three agencies, all of which have substantial bandwidth needs, fiber capacity and in-house expertise. Sharing arrangements are relatively informal and further core agency missions.

The most extensive sharing arrangements are seen in multipurpose, multi-agency consortiums. In these cases, sharing may encompass operations, maintenance and financing. The most extensive examples are found in Austin and Portland. These consortiums tend to involve a half-dozen or more agencies, some of which possess no fiber system of their own and little or no expertise. Agencies' bandwidth needs are sufficiently modest that the overall system can accommodate the total need. For many consortium members, building their own system would be cost-prohibitive. Consortium membership is the lowest-cost path even if reaching agreement on MOUs is time consuming.

Agency expertise and software standards are shared in most cases. Sharing levies no direct or tangible costs and mutually beneficial relationships can be established informally.

Transportation uses such as video camera feeds create bandwidth demands that currently tend to exceed the capacity of multi-agency fiber optic networks.

Austin, New York City and Portland each have fiber optic systems dedicated to transportation needs in addition to multipurpose, multi-agency efforts. Transportation agencies' bandwidth needs necessitated the dual approach—the multi-agency systems cannot allocate sufficient bandwidth for transportation purposes—in particular, the bandwidth needed to connect video cameras to traffic centers. (It should be noted that multipurpose and transportation systems are usually linked so that agencies on both systems can communicate if desired.)

As fiber cable has become cheaper and with wavelength division multiplexing further reducing costs per megabyte, it may be possible for multipurpose systems to meet the voracious bandwidth needs of transportation agencies.

Fiber optic technology continues to advance and there are some new opportunities for sharing including wavelength division multiplexing (WDM). Sharing arrangements should be flexible enough to accommodate changing technology.

Using franchising agreements in conjunction with an overall fiber optics plan or vision is a very cost-effective method to develop a fiber optics communication system.

Franchising agreements offer cities the opportunity to obtain fiber capacity at no cost or for only the incremental cost of adding conduit for city purposes. Even the incremental cost is much less expensive than a dedicated installation. This approach is much more effective, however, if the city first prepares a plan detailing its fiber optic needs by location and capacity. Such plans enable City staff to quickly evaluate whether to piggyback on a given private construction project.

The decision to utilize a privately owned and operated fiber system as opposed to a public system for public purposes is a critical decision point. Cities may face political opposition to the notion of creating a public communications system. In that case, sound cost information on the benefits of a public system is required.

Houston is a prime example where private companies sought to provide telecommunications services. Although the system was built by public agencies, private sector interest was taken very seriously in the political process and caused a two-year delay in the project.

Other cities have not faced this problem, apparently for a variety of reasons. ITS systems dedicated to transportation uses seem to be less of a target if they are not on routes desirable to private companies. In some cases, incremental development has presented less of a target for private development interests. In other cities, officials were baffled by lack of private sector opposition to a city-built network.

Technical expertise in at least one of the agencies is necessary to deal with the complex issues and to interact meaningfully with the private sector.

As with traffic management, technical expertise is critical to planning, procuring and managing a fiber optic network. Multipurpose, multi-agency sharing in Austin, Portland and Denver utilized substantial in-house staffing.

Long term funding commitments to operations and maintenance are necessary for a successful sharing arrangement. Multi-purpose fiber sharing can foster greater local support for adequate funding.

O&M funding has been a particular challenge to transportation agencies operating ITS systems built with federal funds. Multipurpose systems appear to have had less difficulty obtaining adequate local funding, presumably because their multiagency constituency provides a broader base of political support.

The implementation of a shared ITS can facilitate a program of wider fiber optics sharing.

As with traffic management inter-jurisdictional cooperation, fiber optic sharing can be built in a building-block manner. In Portland, the initial sharing was among transportation agencies. When the transportation agencies needed access to city streets, the multi-agency, multi-purpose sharing benefits became evident and the agencies were able to build on the success of the initial sharing among transportation agencies.

Documentation of the sharing arrangement is necessary for the future but flexibility is necessary to handle unforeseen events.

In Portland, the participants in the sharing arrangement recognize that a part of their success is due to the interpersonal relationships that have developed as part of the process. However, they also recognize that people move on to different jobs or positions, so there is a need to document the informal arrangements so that successor participants know who agreed to what and to set a base for future arrangements. Both Portland and Houston stress that the agreements should be flexible enough to accommodate changes in technology as well as unforeseen needs, i.e., the addition of a light rail system to the Houston transportation network.

NEAT IDEAS FOR LARGE CITIES

This section summarizes several innovations that proved successful in developing shared fiber systems and appear to have particular relevance to large cities.

1. **Fines for fiber cuts.** A major operational and maintenance problem for cities involves preventing and repairing cable cuts in the fiber system. Cuts in the network are expensive to repair and can disrupt operations while the system is down. Santa Clara County recently enacted an ordinance that levies $1500 per day fines on contractors for unrepaired fiber cuts. These fines have substantially reduced this problem.

2. **Piggybacking through purchase orders.** The City and County of Denver has used purchase orders to "piggyback" on private telecommunications companies' conduit installation. During the permit process, Denver staff compared the company's plans with City and County of Denver's planned fiber network. The purchase order process is then used to pay for the incremental cost of an additional conduit for Denver's use where advantageous to the city/county's network.

3. **Notification system.** Boston has introduced a procedure whereby telecommunications and electronics companies must notify one another when they plan to dig beneath the streets. Anyone planning to install conduit beneath the same streets must become a "participating" company with the lead firm. This prevents repeatedly digging up the same streets.

4. **Establishment of a Technical Coordinating Committee.** The Portland area established the Cooperative Telecommunications Infrastructure Committee (CTIC) to facilitate the development of a multi-agency, multi-purpose fiber optics network. The CTIC has a statement of purpose and an agreement signed by all parties. It meets monthly and is a decision body as well as serving as a communications device.

5. **Use of "Enterprise Funding."** The Portland Bureau of General Services, Communications and Network Services (ComNet) operates as an enterprise fund. Their funding comes from fees charged to other city agencies for the telecommunications services that are provided. There is a general feeling within the Portland government that operating under an enterprise fund concept creates an "entrepreneurial" atmosphere within a governmental structure that promotes the exploration of new ways to conduct business. The creation of the internal communications system in Portland (IRNE) is attributed in part to the enterprise fund structure of ComNet.

6. **Peer Reviews and State of the Practice Scans.** In implementing the city agency sharing arrangement, the City of Portland hired a consultant to analyze the state of the practice in other areas both as an internal check for their plan and also as a selling document to the city council. They also extensively engaged in peer reviews with other cities before going forward.

Table 2. Summary of Features for Fiber Optic Sharing.

	Portland	Austin		Houston	San Jose	Denver	New York*	Boston
		GAATN	Traffic signal					
Part of ITS program	✓		✓	✓	✓	✓	✓	
Multipurpose sharing	✓	✓				✓		✓
Formal MOU	✓	✓		✓	✓	✓	✓	
Sharing involves								
Conduit	✓	✓		✓	✓	✓		✓
Fiber strands	✓				✓	✓		
M&O costs	✓	✓		✓	✓	✓		
Expertise	✓	✓	✓	✓	✓	✓	✓	
Obtaining capacity								
Part of h'wy/bridge/-arena/transit construction	✓			✓		✓	✓	
Piggyback on private sector installations	✓		✓	✓		✓	✓	✓
Built specifically for project	✓	✓	✓	✓	✓	✓	✓	

*Transportation agency sharing.

4. CITY OF PORTLAND/PORTLAND AREA FIBER OPTICS SHARING AND COOPERATIVE AGREEMENTS

PROJECT OVERVIEW

Governmental agencies within the City of Portland and in the greater Portland area have come together to create a fiber optics backbone system by sharing fiber optics cables, conduits, related infrastructure, operating software and maintenance and operations. Based on our research this arrangement and the resulting communication systems can be described as a " best practice" in the country. The best practices include:

a) The blending of network assets; physical, technical, financial and operational

b) The partnering of multiple agencies and leveraging of many applications onto a planned high-capacity architecture

c) Open access to the Internet

The sharing arrangements serve different programmatic objectives of the participating agencies. In each instance the participating agency has made the judgment that entering into a sharing arrangement meets two important tests:

- The sharing arrangement provides benefits to the agency objectives
- The sharing arrangement is in the overall public interest of the residents in the Portland area.

The sharing arrangements in the Portland area can be viewed from two major programmatic objectives. The first is the implementation of a multi-agency Intelligent Transportation System (ITS) for the area with a focus on traffic management, incident response and traveler information. The second program objective is the development of an Integrated Regional Network Enterprise (IRNE) within the City of Portland to interconnect all city agencies and partner locations with a high capacity communications system for voice, video and data communications.

The development of the fiber optics backbone system is facilitated through the Cooperative Telecommunications Infrastructure Committee (CTIC). The committee meets monthly to discuss and resolve issues, monitor the progress of the fiber optics system and ensure that the resulting system is compatible for all participants. Subcommittees meet more frequently on technical matters. "CTIC was formed to share the region's publicly owned telecommunications assets- fiber optic plant, conduit, cable, I-NET, wireless voice and data plant and other assets. Rather than overbuild each other, creating expensive single application networks, the partners opted to pool their resources." The current members of CTIC are the Oregon Department of Transportation represented by Dennis Mitchell, the Traffic Engineer of the Portland region office (ODOT); TRI-MET, the region public transportation provider, represented by Ron White, the Network and Systems Manager; The City of Portland Department of Transportation,

represented by Rich Johnson, the Signals Division Communications Engineer and the City of Portland Bureau of General Services, Communication and Networking Services Division Director of ComNet, Nancy Jesuale. CTIC is looking to expand its membership and scope to include the State of Oregon statewide communications system and several education and public safety related systems.

The Portland area is known nationally as an area of progressive and cooperative government. The Smart Growth initiatives and the joint concern for environmental issues have been well cataloged in national publications. The area has a metropolitan government, METRO, which is responsible for many planning activities and regionwide services. METRO also serves as the MPO for the area. It is against this backdrop of generally cooperative government activities that the fiber optics sharing program can be described.

HISTORY AND AGENCY PERSPECTIVE

The fiber optics system sharing arrangement can best be understood by presenting the history and perspective of this arrangement from the viewpoint of each participating agency.

Oregon Department of Transportation (ODOT)

The ODOT is broken into 5 region offices and a number of districts within each region. The culture of the organization is to decentralize decision-making as much as possible to the region offices. It is against this backdrop that the Portland Region Office of ODOT started to implement a freeway surveillance ITS program as part of a regionwide ATMS (Advanced Transportation Management System) program in 1993. The ITS program for the region, TRANSPORT, is fairly standard with traffic management, incident management and traveler information components and thus will not be reported here in detail.

While ODOT had some conduit in place along the freeways, ODOT found that there was a need to utilize city streets in order to connect the freeway system to their control center. Thus, they began to develop a joint arrangement with the Portland DOT. Under the initial agreement, the state would put in the fiber and the city would give the state access to reserved pole space above the city streets. The state would then give the fiber to the city to maintain and the fiber would be shared for both city and state purposes. ODOT also discovered that in one corridor TRI-MET already had fiber optics cable along an adjacent transit corridor and that it was more cost effective to utilize excess TRI-Met capacity than to build their own. Thus the initial notion for sharing fiber systems came from coordinating with Portland DOT and TRI-MET on these two relatively isolated gaps in implementing the freeway surveillance ITS. As will be described later, the success of these activities led to a wider review of sharing opportunities.

a) From the perspective of the ODOT region office, the sharing arrangement:

b) Facilitates implementing the ATMS plan

c) Provides redundant paths in the event that one of their fiber cables is inoperable

d) Gives access to information on arterials

e) Is overall cost-effective and in the public interest

TRI-MET

TRI-MET developed a communications plan which would link all of their operations with a high capacity SONET system. When ODOT came to them on sharing fiber capacity in one corridor they were able to accommodate the request. Furthermore, TRI-MET saw the opportunity for a regionwide approach to sharing that would facilitate the implementations of their communications plan. TRI-MET convened the first meeting of the group that is now CTIC. From their viewpoint the sharing arrangement:

a) Allows them to implement their communications plan more cost effectively by utilizing existing conduit of other agencies and trading off excess capacity in their own system

b) Provides redundant paths in the event that one of their cables is inoperable

c) Is in the public interest

City of Portland

There are actually four agencies within the city structure involved in the sharing arrangement as well as the City Council.

1. Office of Cable and Franchise Management. Many companies have come to the City requesting access to city streets for either underground conduits or for air space for overhead cables. In exchange for access to city streets the companies were required to place two conduits for city use for underground facilities or reserve three feet of pole space for the city for overhead cable applications. At that time there was no plan for utilizing this capacity except for the notion that eventually the city would have a need for an internal communications system. Therefore, when the sharing concept was first discussed, there was a significant unused asset available to the group: the reserved infrastructure put in place through the franchising process.

2. Portland Department of Transportation (PDOT). PDOT began working on the implementation of the ATMS in 1992/93 following the results of an early deployment planning process. The City maintains and operates 958 traffic signals, has 8 video cameras and several count stations for monitoring traffic flows. Two thirds of the signals are connected to a central traffic signal system. The city has a small traffic control center for the coordinated signal program. The city has the responsibility for traffic control on city streets and for state arterials within the city. While the county owns the bridges across the river in the city, the city also has traffic operations control for the bridges.

The original fiber optics sharing agreement was between the PDOT and ODOT as reported previously. Today, PDOT is a member of the CTIC and utilizes the shared fiber network as part of implementing the citywide signal coordination/ATMS program. In addition, PDOT has a communications engineer on staff who provides technical services to all members of the CTIC.

3. Bureau of General Services (BGS). The Communications and Network Services Division (ComNet) of BGS is responsible for providing external communications capabilities (voice, video and data.) for all city agencies including communications between city agencies and communications for city agencies with external groups or individuals. BGS operates as an enterprise fund; that is, they receive no city general fund budget support, rather they generate operating and maintenance funds by providing services to city agencies and charging the agencies for their services. While still under the overview of the City Council, the agency has more independence and incentive to try new ideas. In the past BGS was a "reseller" of services provided by private companies. For example, BGS had negotiated a citywide contract for "centrex phone service" with a private telecommunications company and then resold the service to the individual agencies.

A new director of ComNet, Nancy Jesuale, was appointed 4 years ago and saw the opportunity to link several existing activities into a coordinated system, IRNE, which would provide better communications capability to city agencies as well as provide a lower overall cost to city agencies. The sequence of activities which were linked were:

a) Mapping the existing available conduits and pole space obtained over the years from the city cable and franchise management

b) Overlaying the city conduits and pole space network on the ODOT/TRI-MET/PDOT ITS fiber optics systems to create an areawide shared fiber Optics network,

c) Determining the future data and voice communications requirements of the various city agencies.

d) Developing a citywide funding program to meet the needs of the city agencies.

By adding interagency voice communications to the shared fiber network, BGS determined that the net communications cost could be reduced. In essence, BGS could finance a citywide wide area network to meet the future needs of the city agencies for video, data and voice communications with the funds which were currently being expended to provide voice communications through a private communications company. The City would take over the responsibility for voice communications through IRNE and eliminate the need for the private company. A large part of the cost savings is achieved by participating in the development of the shared fiber optics system through CTIC. The total fiber network for the citywide area network will be about 50 miles. About 30 miles of fiber will come from shared arrangements (other agencies fibers) under CTIC. A significant portion of the remaining fiber will come from a franchise agreement where in lieu of providing new conduit space, the franchisee will lay new cable for the coordinated

fiber network. City agencies will be getting the same voice communication service and the video and data transmissions through the wide area network will be free. The system will also provide agencies with a telecommunications infrastructure to promote e-commerce and open Internet access for citizens.

BGS estimates that they have spent a total of $250,000 to get IRNE to the stage of Commission approval. The total budget for the project is $8 Million and the target completion date is April 2002. The city will borrow to finance the initial cost of the system. The current citywide agency cost for internal telephone service is about $2.3m/yr. These revenues will now be redirected to finance the IRNE capital cost, pay for maintenance and operation and in addition create a depreciation fund that is projected to be sufficient in 14 years to change the system over to the next future technology platform.

BGS is also a seller of services to other governments, universities, schools, counties etc. The continuation and expansion of these services under IRNE are also part of the cost equation. In addition the staff will pursue other coordination efforts with the statewide state government communications network and other similar public sector communications programs.

A short technical summary of IRNE is included in the appendix. There are many technical issues regarding IRNE that are also covered in an accompanying document. Technical issues will not be described in this report since the scope of this report is really on institutional arrangements for sharing fiber networks.

4. Bureau of Information Technology (BIT). This bureau is responsible for developing and maintaining local area networks (LANs) within the buildings of city agencies. The Bureau of General Services coordinates with BIT to connect the LANs into the wide area network.

The role of the City Council should also be noted. The City of Portland is a central city with a population of roughly 575,000 in a metro area of nearly 2 million. The City of Portland is run by a commission form of government. Four Commissioners and the Mayor serve as both the City legislative body (The Council) and as administrators of city departments, individually overseeing bureaus and carrying out policies approved by the Council while wearing its legislative hat. The assignment of departments and bureaus is determined by the Mayor and may be changed at his/her discretion. The Mayor, four commissioners and the Auditor comprise the City's six elected officials. All are elected at-large on a non-partisan basis and serve four-year terms. The terms are staggered on a two-year cycle with the Mayor and two commissioners elected on one cycle and the other two commissioners elected two years later. Three of the commissioners oversee the four agencies involved in IRNE, which ensures a majority of the commission support for the project if all three commissioners support the concept.

MAIN LESSONS LEARNED/ IDEAS FOR LARGE CITIES TO IMPLEMENT

1. Communications network sharing is more than six fibers for you and six for me. The members of CTIC, in their memo of agreement (attached), quickly recognized that

sharing was much more than counting fibers. Sharing has also included the sharing of the unique technical expertise which exists in each agency, sharing of software programs so that all agencies have the capability to readily share information and jointly creating the capability to incorporate advanced technologies such as Wave Length Division Multiplexing on a coordinated basis. The agencies will be able to share video output from any of the surveillance systems including the ability to position other agencies camera.

2. The spirit of the cooperative effort was to operate as a mid-level technical activity, below the political radar screen, and to accomplish as many joint activities as possible within each agencies programmatic responsibilities. Political sanctioning was sought after a substantial coordination effort was already in place and the group was ready to go to the next level (IRNE). Members of the CTIC continued to use the two tests: good for the agency and good for the general public. Their advice to other cities is:

    - To create a vision,
    - Recognize that all agencies have the same customers,
    - Start small and build on successes,
    - Keep the initial applications simple but also preserve future options, and
    - Have some technical expertise in communications systems available at the agency level.

3. The group does not keep a balance sheet, for example, the cost of fibers donated or received by each agency. Since the sharing involves more than fiber strands, keeping a balance sheet of technical expertise or software sharing would be difficult and perhaps counter productive to the spirit of the cooperative effort. The CTIC uses group dynamics more than formal agreements to ensure that any one agency doesn't try to take advantage of the cooperative effort.

4. To a person the participants credit the success of this effort to the personalities involved in the exercise and to the level of technical expertise represented at the table. All members consider each other as friends and say that they look forward to each meeting as their "most productive" meeting on their calendar. They all feel that what they are doing is good for their agency and is "what the public would expect of governmental agencies." The group has developed a high level of trust and respect for each other and for the respective programs of each agency. They recognize that there will be thorny issues ahead as new participants come into the process and as technology advances but they feel confident that they can cooperatively work these issues out.

5. The members recognize that the personalities will change over time and are now going through a process of documenting the sharing arrangements so that if one or more of the key participants leaves, there is a record and continuity to the process. To

the extent possible the agreements are technical in nature and do not require legal review.

6. The group has adopted a philosophy of "doing it if it makes sense" rather than asking permission first and then doing. While other areas have cited federal transportation requirements as impediments (some of the fiber systems were paid for with federal transportation funds) the CTIC feels that since the initial cost was fully justified for transportation purposes, that the additional use for public information sharing, including public safety purposes, is consistent with federal requirements.

7. One of the keys is to tie the city franchising of cable and telecommunications systems to the overall vision for a fiber network, especially during the creation of the ITS backbone communications system. Portland did not do this initially but was fortunate to have required the installation of conduit and the reservation of pole space in previous franchising. Now that they have a vision and a program they are proactively using the franchising process to help achieve the vision. The members of CTIC felt that they should have started the sharing process years ago, but even starting at this late date has created many new opportunities.

8. One of the current constraints is the unavailability of fiber cables. The CTIC estimates that there is a one-year backlog of orders for fiber cable. Current production is committed to large long distance companies.

9. The ability to deal with the political power of the private providers is important for any city attempting to establish a government owned network. Cities need to understand and anticipate political pressure. The CTIC has been able to agree that the fiber optics network is one system with common standards, common software and a common management system. This common coordinated approach has allowed the group to fend off attempts by the private sector to divide and conquer. The Portland network is accessible only for government purposes so one of their arguments is that they are not competing with the private sector for private customers.

10. New members to the shared network must have both a long range plan as well as a long term funding commitment. The CTIC will only add new members if the new members have a long range plan and long term funding to sustain the plan. Several organizations have approached the CTIC with one-time grants in hand but without a long-term commitment or funding. While CTIC will cooperate with these efforts, without a long-term commitment, future maintenance and operation responsibilities would fall on CTIC members if the agency grants are not renewed. As an example, METRO received grant funds to create a regional government information network. The network operated for several years but when the grant funding was not renewed METRO turned off the switch leaving some municipalities and agencies without connections.

11. Political leaders in Portland attribute the success of CTIC and IRNE to a government culture that is willing to try new things, encourages taking calculated risks and which can tap into the latent entrepreneurial spirit of some city agencies. There are a

number of enterprise funds in city government in addition to BGS. While there is always political tension among the different levels of government, this effort is under the political radar and is generally accepted as a good government activity.

12. Documenting the physical network, the components of the network and the responsibilities for each component is important. The CTIC is developing a fiber optic route agreement or standard operating procedure where:

    - Each fiber optic segment will have a unique descriptor.
    - The owner, and thus the agency responsible for maintenance, will be noted.
    - The number of fibers allocated to each agency within the segment, color coded to that agency, and an asset manager identified from that agency.
    - A description of the physical assets including conduits, street poles, patch panels, fiber optic cables, inner duct, duct banks, pull boxes, communications cabinets, etc.
    - One or more fibers will be designated as maintenance fibers to allow any agency to "shoot the system" (test the system)

Once this agreement or procedure is completely filled in, it will serve as the "as built" plan of the network. Eventually this information will be incorporated into the software that is being jointly purchased which will manage the entire system. The details and format will be worked out in the next months.

The CTIC memo of agreement, City Council resolution to implement IRNE and a technical summary of IRNE can be found at the end of this chapter.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

Fiber allocation is determined by the CTIC through a cooperative discussion process. The principle to date is to allocate fibers based on agency need. At this point there is excess capacity in the fiber systems but the group feels that multiplexing can enhance future capacity.

2. What is the arrangement for O&M Responsibilities?

Final arrangements for O&M are still being developed. There is agreement that the financial responsibility for maintaining the system remains with the owner who built the system. There is also an agreement to use the same contractor for first response restoration. CTIC may use PDOT for preventative and routine maintenance and the contractor for emergency restoration. The city is creating software that will monitor the entire system and will hire a consultant to monitor the operation of the system, to detect problems and then notify the owning agency to initiate maintenance procedures.

3. How are costs allocated? What is the cost for tapping into the system?

Within the CTIC cost sharing is worked out informally depending on the needs of each agency, what each agency can bring to the table, (i.e. existing conduit, technical expertise, etc.) and the maintenance and operations rules adopted by the agencies. Within the city administration, each agency is required to utilize IRNE by direction of the City Council (Copy of resolution attached). As noted previously any new agencies wanting to be part of the system must come with a long-term plan and long term funding. The group is talking to several perspective new members but no new members have been added.

4. How are the capacity needs determined?

The CTIC has set a 48-fiber cable standard for laying new cable for use by CTIC members. The allocation of the fibers to agencies is based on needs of the agency. Future capacity will be allocated in the same manner.

5. How are demarcation lines (firewalls) established between agencies and the backbone?

The agreements now being drafted will show the color-coded networks of each agency within the cable. Agencies have the ability to create "firewalls" for their system. Sharing the same fiber by use of multiplexing has not been discussed although that option is reserved for the future as well.

6. How have the agencies used franchise arrangements? What is the impact of utility deregulation?

Utility deregulation has made this sharing arrangement possible. With deregulation have come many applications for companies to install fiber and other communications systems, which in turn presents the opportunity through the franchise process to get something in exchange for access to rights-of-way. The key is having a vision of what government wants and using the franchise process to help achieve that vision.

7. Are there security issues, especially for emergency services?

At this point there are no security issues on the table. Emergency agencies within the City are included in the system. The nature of the design, which includes redundancy and the ability to create firewalls, has satisfied the various interests.

8. How can cities effectively contract with private sector firms in a rapidly changing market?

In this case study, the City of Portland is "uncontracting" with the private sector to create its own government network. They are working cooperatively with private companies on providing access for fiber optics systems including a unique project that will give IRNE a portal to the private "Internet Hotel" in exchange for access to city owned conduit.

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5. HOUSTON CASE STUDY ON FIBER OPTIC SHARING

PROJECT DESCRIPTION

The Houston area provides a case study of the sharing of fiber optics systems among transportation agencies. To fully understand the Houston fiber case study, the reader should first read the Traffic Control Center section of this report and in particular the section on Houston TranStar. The fiber sharing and the transportation projects are under the umbrella of TranStar.

The goal of the participants (Texas DOT, METRO, Harris County and the City of Houston) is to establish a fiber backbone network that will link the TransStar Control Center and the operations offices of the participating agencies with the transportation facility control systems. Previously, several fiber optics systems were developed separately as part of TranStar capital projects, most notably the control systems on TxDOT freeways and the METRO HOV lanes. In the City, utilities were required to string a wire for traffic signal communications as part of fiber optics franchising agreements. The County is building its portion of the Regional Computerized Traffic Signal System (RCTSS), which includes a communications network. METRO is developing a communications system to link its 6 bus facilities and IT data center.

METRO had the lead for developing the RTCSS in the city and had established a budget for the system based on negotiations for a federal grant (Note that the funding arrangement is unique in that the signal system is being upgraded using federal transit funding under the premise that the major goal of the system is to increase bus speeds). One of the goals of RTCSS is to provide video capability as well as data connectivity thus increasing the communications bandwidth requirements. METRO discovered that 20-30% of the proposed $120M budget was needed to provide voice, video and data communications with video being the major component. In addition METRO was developing a system to connect their six service facilities with a fiber system. METRO also serves as the system integrator for the fiber network.

As METRO went to implement the communications component of RTCSS, they received pressure from private communications companies to open the development and construction of the communications network to the private sector. One company initially offered to provide communications for a twenty-year period at a low price. METRO developed a proposal package for a ten-year contract with extension options. After a strong initial response to expressions of interest, the final biding process resulted in only one proposal received at a cost that was much higher than the budget allowed. The participants say that among the factors which led to the high cost were the specific long term requirements (i.e. performance and service standards) which were required to be included as part of getting governmental approval for a procurement project. The result of the attempt to develop a private sector contract was a significant loss of time in implementing RTCSS (2 years), frustration on the part of both sides and a number of lessons learned (see next section).

The fiber optics network being developed under the TranStar umbrella is still evolving. At this point there are no formal agreements but a working agreement on implementation of a fiber optics backbone system. This system includes sharing existing fiber optics cable and sharing future cable that will be installed as part of RTCSS and other transportation projects. The benefits of such arrangements are different among the different agencies but in all cases are described by the participants as win-win. For example, the county RTCSS will connect to the state fiber system to gain access to the TranStar control room while the state will connect to the county system to gain redundancy for their system in the event of a system interruption.

The issues of available bandwidth and capacity limitations are still significant. The state system is limited to 48 fibers. The proposed fiber optics sharing system has created two specific and somewhat opposing viewpoints related to fiber optics systems sharing. Some agencies favor physically separated fiber systems within the same conduit—you get six wires and I get six wires. METRO feels that Wave Length Division Multiplexing, a technique now being used by the private sector to increase system capacity, can solve the capacity issue. These issues continue to be discussed within the umbrella of TranStar.

LESSONS LEARNED

1. There is a need to clearly present the issues regarding accomplishing a master plan for communications systems, budget constraints, specific project needs, and project constraints.

2. Do not underestimate the pressure (technical, political etc.) to consider leased-line options from utilities and other communications providers.

3. There needs to be an understanding of the difference (benefits, costs, risks etc.) of sharing conduits with separate wires vs sharing the same wires (Wave Length Division Multiplexing)

4. Sharing agreements should be as simple as possible because it is impossible to anticipate tomorrow's technology on bandwidth, multiplexing, fiber capacity, etc. Do not allocate bandwidth in advance and keep details out of any agreement. Agreement on general sharing principles with future flexibility are preferable. Using government procurement contracts often limits the amount of flexibility.

5. Agencies value savings in operations costs higher than savings in capital costs. Pay attention to O&M costs upfront.

6. Agency staff in Houston say that there is a constraint on federally financed transportation fiber optics systems projects from sharing the fiber with non-transportation agencies. Yet other areas are sharing with non-transportation users under the general goal of public safety.

7. In-house technical capability is essential to developing a communications system, not only for implementing the various components but also for dealing with private sector

proposals and pressure. Having one agency (METRO) be the system integrator is also important.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

At the current time, the agencies are dedicating a certain number of fibers to an agency based on need and capacity. The agencies are discussing Wave Length Division Multiplexing.

2. What is the arrangement for O&M responsibilities?

The current arrangement is that the agency that owns the fiber system is responsible for the maintenance.

3. How are costs allocated?

Costs have not been allocated among agencies. Since the sharing arrangement is under the general umbrella of TranStar, the overall cost sharing arrangement of TranStar is in place.

4. How are capacity needs determined?

The capacity needs are still evolving which emphasizes the need for flexibility. The existing Texas DOT and METRO HOV fiber systems have limited capacity. The RTCSS system is being developed. An example of the need for flexibility arose with plans for a light rail system, supported by the new METRO administration and the new Mayor. The light rail system will need fiber optics communication capability. This option was not on the boards two years ago.

5. How are demarcation lines established between agencies and the backbone?

At this time, each agency has its own fibers.

6. How have agencies used franchise arrangements?

The City has used the franchising process to develop the internal fiber system for RTCSS. Organizations are required, as a condition of the franchise, to install conduit on city streets and to include one cable for RTCSS. In addition, the City is active in reviewing new developments. If additional signals are required, they must be compatible with RTCSS.

7. Are there security issues, especially for emergency services?

Emergency services are integrated into TranStar.

8. How can cities contract with private sector firms in a rapidly changing market?

The experience of METRO in trying to develop a private sector communications system shows the problems associated with the incompatibility of long-term government contracts and the rapidly changing market.

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6. NEW YORK CASE STUDY ON FIBER OPTIC SHARING

PROJECT DESCRIPTION

Transportation agencies in the New York City area have developed and shared fiber optic networks over the past decade. The pattern has been for each agency to install fiber optic capacity on its own right-of-way, followed by connecting fiber of different agencies to link management centers with each other and with field equipment.

The New York State and New York City Departments of Transportation each built fiber capacity starting in the early 1990s to link their respective traffic management centers with field equipment such as closed circuit television (CCTV), traffic detectors and variable message signs. The State's initial development was based on an ITS Early Deployment study. The initial links involved NYSDOT's fiber on the Gowanus Expressway in Brooklyn, installed during highway rehabilitation, and NYCDOT's fiber between its traffic management center in Queens and the Williamsburg Bridge in Brooklyn. The two agencies then connected their fiber, thus linking the Gowanus Expressway and Williamsburg Bridge to each agency's TMC in Long Island City.

The fiber network has been and is being further developed. Several approaches are used. One approach is to include fiber installation or new duct capacity in major capital work. The light rail line running from Jamaica, Queens to Kennedy International Airport, currently under construction by the Port Authority of New York and New Jersey, will have ducts available to NYSDOT. The State is also building conduits during reconstruction of the Long Island Expressway and Route 9A on Manhattan's west side.

Another avenue is taking advantage of the City's control over valuable rights-of-way. The City's franchise agreement with the company owning ducts under streets throughout Manhattan has long provided for free duct access to city agencies. More recently, a revised franchise with Consolidated Edison provided for free duct access, thus opening access to the other boroughs. A franchisee also provided access for the Queensboro Bridge fiber installation.

Fiber will also be installed as part of two recent NYCDOT initiatives. First, the Integrated Incident Management System (IIMS) will use a mix of fiber and other communications technologies to link transportation management systems with the Police Department. This will likely be expanded at a later date to include the Emergency Management and Fire departments.

Second, N.Y.C. DOT, New York City Transit (operator of the city bus and subway system) and MTA Bridges and Tunnels (operator of water crossings between boroughs within the city) recently obtained federal funding for a cooperative fiber network with video and other information sharing. The fiber network will carry video feeds and data generated by the three agencies. The agencies are developing plans to connect the interagency network with fiber running throughout the subway system.

Fiber optic sharing among transportation agencies in New York is separate from other City networks. The N.Y.C. Department of Information Technology and Telecommunications (DOITT) links city buildings with a fiber backbone, cable, T1 and T3 lines. Due to capacity constraints of this system, however, NYCDOT has needed to develop its own fiber network. It should also be noted that City DOT's fiber complements an extensive existing system of coaxial cable and T1 lines that interconnect traffic signals in Manhattan.

LESSONS LEARNED

1. A key to fiber sharing is building excess capacity. The linking and sharing between City and State DOT is made possible because each agency had (and has) available capacity to share with the other agency. Since the major cost is in accessing rights of way and installing ducts, the cost of increasing the number of fiber strands is minimal, particularly in relationship to the benefit of trading capacity with other agencies.

2. Fiber sharing does not necessitate a central coordinating or oversight function but can be accomplished with peer-to-peer interagency cooperation. Notably, these relationships involve a small number of large agencies in New York.

3. Fiber capacity can be developed over time, taking advantage of opportunities that arise with major capital projects and the use of franchisee's right of way.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

To date, there has been sufficient bandwidth to accommodate each transportation agency's needs, and thus no need to formally allocate fiber capacity. Lack of capacity has kept City DOT from using the DOITT network, however.

2. What is the arrangement for O&M responsibilities?

Each agency is responsible for maintaining its own fiber. Maintenance is part of the contract during construction. At the conclusion of construction or reconstruction of state highways, the highways will be turned over to City DOT. Ongoing O&M funding will be worked out at that point. Funding mechanisms will be included in a memorandum of understanding being developed between State and City DOTs.

3. How are costs allocated?

Each agency is responsible for costs on its own facilities.

4. How are capacity needs determined?

NYCDOT has sought to install capacity well in excess of current needs. For example, on the Queensboro Bridge, DOT ran 280 fibers, up from 188 fibers for highway installations.

5. How are demarcation lines established between agencies and the backbone?

This question is not relevant to the New York situation since there is no backbone.

6. How have agencies used franchise arrangements?

Franchises have been very important in New York. The City DOT has used duct access rights in utility franchises.

7. Are there security issues, especially for emergency services?

There have not been security issues for the transportation agencies. The IIMS system involving NYPD includes stringent security measures, although these are more important for over-the-air communications.

8. How can cities contract with private sector firms in a rapidly changing market?

Private companies have been used as contractors for construction and franchisee's duct access has been used. No other arrangements have been carried out.

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7. SILICON VALLEY CASE STUDY FIBER OPTIC SHARING

PROJECT DESCRIPTION

Fiber sharing in the Silicon Valley area has occurred as part of the Silicon Valley Smart Corridor project, the first project built by the Silicon Valley-ITS Program, led by the City of San Jose. The communications component of the Smart Corridor project utilizes a variety of technologies including fiber optics, frame relay and leased telephone lines. The fiber component involves 35 miles of fiber optic cable installed to connect six local agency traffic management centers with one another and with field devices. Frame relay is used to provide communication to the Caltrans (State DOT) traffic management center, located in Oakland, about 40 miles north of the corridor.

The Smart Corridor project is a partnership involving ten agencies:

- City of San Jose
- City of Campbell
- City of Milpitas
- City of Santa Clara
- Town of Los Gatos
- County of Santa Clara
- California Department of Transportation (Caltrans)
- Santa Clara Valley Transportation Authority (VTA)
- Metropolitan Transportation Commission (MTC)
- California State Highway Patrol (CHP)

Planning for the Silicon Valley Smart Corridor began in the early 1990s when the "Smart Corridor Statewide Study," prepared for the State DOT, identified I-880 as a prime candidate for an implementation of a "smart corridor." This was followed with a 1994 feasibility study to identify the phasing of projects necessary to deploy a smart corridor. The City of San Jose awarded the design contract in 1996; the County of Santa Clara awarded construction contracts in 1997 for the first three phases of the project. Federal funds totaling $7.5 M were secured to complete this work.

The City of San Jose had previous experience in deploying ITS around its downtown sports arena and had the staffing resources to manage the design contract. The County's regional influence, combined with its expressways serving as key elements of the corridor, made it the appropriate agency to lead the construction management effort.

Two agreements were completed among the ten participating agencies to facilitate design and construction of the Smart Corridor. These include a memorandum of understanding (MOU) outlining the intent of all agencies to work cooperatively on the project and an agreement between San Jose and the County on transfer of funding responsibilities to simplify reimbursements for the construction activities. As the SV-ITS Program has developed during implementation of the project, the partnership is developing a

cooperation agreement detailing the roles and responsibilities of each agency for design and construction; and an operation and maintenance agreement. These agreements will permit the partnership to pursue projects near the airport, northward to the adjacent county, and westward to other Silicon Valley cities.

When capacity permitted, fiber optic cable was installed in existing conduit. However, significant lengths of conduit and cable were installed by trenching and boring into existing roadways. Depending on the location, 12 to 84 fiber strands are in each cable. The project design provided spare "dark" fibers with the anticipation of future ITS needs.

LESSONS LEARNED

1. San Jose and its program partners built a substantial fiber optic network as part of a federally funded ITS project. By making fiber installation part of a much larger transportation project, separate funding did not need to be obtained.

2. O&M costs and arrangements are important issues that are still being worked out. The existence of San Jose's earlier ITS effort ensured that trained staff was in place for new demands.

3. Fiber cuts have been a significant problem. A recent County ordinance leveling a $5,000/day penalty on contractors for unrepaired fiber cuts has significantly hastened the repair process. The partner agencies will be installing markers along the fiber alignment at 500' intervals to reduce the potential for future damage.

4. The replacement of fiber optic cable has become a significant challenge as the demand for the product has grown. Currently, the program has a 52-week wait for replacement fiber delivery.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

Bandwidth is allocated by the project committee. The committee has limited the network to transportation uses that benefit the whole group, not just one member. The Smart Corridor's technical approach was based on a peer-to-peer network, the committee functions in a similar manner. All agencies have equal representation regardless of size or role.

2. What is the arrangement for O&M responsibilities?

Each jurisdiction is responsible for maintenance of the portion of the fiber network within its boundaries. The County has repair equipment; it is contemplated that the County will repair fiber breaks throughout the network on a reimbursable basis. The funding for that has not been arranged as yet, however.

3. How are costs allocated?

Capital costs were covered by federal transportation funds. Each agency is responsible for its own operating costs and for O&M of fiber within their jurisdiction.

4. How are capacity needs determined?

Capacity needs were assessed in the 1994 feasibility study for the Smart Corridor project. Capacity was intentionally overbuilt; however, multiplexing will be necessary on a project basis to meet growing bandwidth needs.

5. How are demarcation lines established between agencies and the backbone?

Smart Corridor is designed as an integrated communications system among the agencies.

6. How have agencies used franchise arrangements?

The Silicon Valley project used available conduit when practical. In all circumstances, the conduit was serving the signal and streetlight systems so it was already under the control of traffic management agencies. Project staff did not approach private sector or outside agencies for use of conduit, or rely on franchise terms.

7. Are there security issues, especially for emergency services?

Security was designed into the system to a level the agencies are comfortable with. The inclusion of emergency services will occur with future projects – the existing Smart Corridor is predominantly a traffic management effort.

8. How can cities contract with private sector firms in a rapidly changing market?

TravInfo, a regional data disseminator, is a key program partner. Data from the corridor is sent to TravInfo via frame relay. The agency gathers that data and makes it available to public and private sector entities to provide commuter services.

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8. AUSTIN CASE STUDY ON FIBER OPTIC SHARING

PROJECT DESCRIPTION

The Austin area is home to a pioneering multi-agency fiber network called the Greater Austin Area Telecommunications Network (GAATN, pronounced Gat-in). The network connects about 275 sites for the seven GAATN members:

- Austin Independent School District
- Austin Community College District
- County of Travis
- City of Austin
- Lower Colorado River Authority
- State General Services Commission
- University of Texas.

In addition to the GAATN network, Texas DOT has an extensive fiber network to transmit highway video feeds. The City of Austin is building a fiber network to connect traffic signals with the city's signal shop. These three fiber systems—GAATN, the City's traffic signal control system and the TxDOT highway system—will be interconnected, allowing agencies to communicate with each other.

GAATN

In the late 1980s, the Austin Independent School District (AISD) initiated plans for a 250-mile fiber network for voice, data and video transmission. During the design phase, the City of Austin, Travis County and Austin Community College approached the District to be included in the design. The parties recognized that a joint effort would be less expensive than separate networks. An interlocal agreement was executed in May 1991, followed by bidding out construction of the network. The other GAATN members later joined the original four partners of the consortium.

The network consists of about 300 miles of fiber arranged in eight rings and two super rings. This design provides redundancy, maintaining communications despite fiber breaks. Most of the network is pole mounted although there is some underground conduit. Four-inch conduit is used with subducts for four fiber runs.

Consortium members jointly own and maintain the sheathing, pole attachments, in-line electronics and similar items. One entity acts as the managing partner. Maintenance costs are allocated based on each participant's percentage interest in the network. Each fiber strand, however, is individually owned by one of the participants. The City of Austin provided access to pole attachments at no cost and received 12 strands in-kind everywhere the network goes.

Highway and Traffic Signal Fiber Networks

The City of Austin is in the early stages of building a fiber system for traffic signal control and video monitoring. The plan is to install 180 miles of fiber and connect all 700 traffic signals in Austin. The network will also carry video images from 80-100 intersections back to the central signals shop. The video system is quite sophisticated; in addition to simply showing intersection conditions it is designed to conduct traffic counts and to follow individual cars as probes through the street system.

Existing conduit that has been used for copper wire is being used where possible. The City is also encouraging joint installations with utilities and telecommunications companies that are also installing fiber. There is no legal requirement that utilities or telecommunications companies share duct access with the City, however.

The City is also constructing an emergency operations center. The center will centralize the City's emergency operations center, Police, Fire and Capital Metro (transit agency) dispatch operations. The county emergency operations center may also join this "combined center." The center will receive video feeds from the City's intersection video cameras and TxDOT's highway video cameras. The center is scheduled to open in 2002.

LESSONS LEARNED

1. Capacity and locational needs have driven the development of separate transportation and inter-agency fiber networks. The networks are interconnected, however. This creates redundancy and makes it possible for agencies to communicate with all other agencies on either network.

2. Austin focused on sharing the most expensive part of the network—installation of capacity—while each participant in the GAATN network is responsible for its own fiber within the system. This has seemed to be a convenient and workable division of shared and individual ownership.

3. In-house expertise and a major commitment of city staff resources are necessary for operation and maintenance of GAATN and traffic signal fiber networks.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

Fiber capacity is not allocated among different agencies. Each agency controls its own fiber in the GAATN system. The City's fiber system for its signal system and TxDOT's highway fiber are controlled by the respective agencies.

2. What is the arrangement for O&M responsibilities?

The GAATN consortium contracts for operations and maintenance of the network. The City Public Works Department and TxDOT foot the bill for O&M of their fiber.

3. How are costs allocated?

O&M responsibilities are shared on the GAATN network through the consortium, as spelled out in an interlocal agreement. The City Public Works Department and TxDOT are responsible for O&M costs.

4. How are capacity needs determined?

Each agency determines its capacity needs.

5. How are demarcation lines established between agencies and the backbone?

Not applicable; each agency owns its own fiber.

6. How have agencies used franchise arrangements?

Franchise arrangements have not been utilized. There is no requirement for city access to franchisee's fiber installations.

7. Are there security issues, especially for emergency services?

Security issues are addressed in design of the networks.

8. How can cities contract with private sector firms in a rapidly changing market?

Contracts have been used for installation of the system.

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9. DENVER CASE STUDY ON FIBER OPTIC SHARING

PROJECT DESCRIPTION

The City and County of Denver is constructing a fiber optic network through a combination of formal and informal arrangements with transportation and other agencies in the Denver area. Agencies involved are:

- City and County of Denver Public Works Department (Traffic Operations) and General Services Department (Information Services)
- Colorado Department of Transportation (CDOT)
- Regional Transit District (RTD)
- City of Lakewood

Through the Information Services Division, various other departments of the City and County of Denver (CCD), including the Police and Fire Departments and various city buildings, are connected to the fiber network. Over 90% of the fiber network is underground. Both federal and local funds have been used.

Most of the CCD's fiber capacity was acquired from telecommunications companies that were installing their own fiber capacity. The City and County of Denver Public Works Department (DPW) paid these companies for the incremental cost of installing an additional conduit along streets that CCD has planned to include in its fiber network. In some cases, DPW made the transaction on a purchase order basis when the telecommunications provider applied for a permit to install conduit. DPW has been able to justify the purchases as a very cost-effective way to gain fiber capacity. DPW has used federal Congestion Management and Air Quality (CMAQ) funds allocated to the traffic signal system for this purpose.

DPW shares fiber with other agencies as the opportunity arises. For example, DPW and CDOT extended fiber conduit along a major arterial street to connect the light rail system and CDOT communications center into the DPW fiber network, thus connecting the three agencies (DPW, CDOT and RTD). CCD has also connected its fiber network to the City of Lakewood's network which is leased from a private telecommunications provider. This link enables Lakewood to connect its traffic signals to the CDOT traffic management center.

DPW has also obtained fiber capacity in conjunction with various governmentally sponsored construction projects. For example, DPW entered into a development agreement with the Metropolitan Football Stadium District under which the District installed conduit and fiber around the new football stadium. This fiber was used to connect traffic signals around the stadium to the traffic signal control system, enabling traffic-responsive control of traffic signals.

When the Pepsi Center was opened a year ago, ITS features such as dynamic message signs and video cameras were installed. In this case, DPW installed and paid for fiber in the area.

CCD also has an agreement with the Regional Transit District to share fiber on RTD's new light rail line. CCD and CDOT have an umbrella agreement, currently in draft, to share fiber where possible.

LESSONS LEARNED

1. The City and County of Denver has spent "pennies on the dollar" for fiber capacity by piggybacking on private fiber construction projects. This has required CCD to have a plan as to where it wants fiber capacity and flexibility to purchase and pay for the incremental costs as the opportunities arise.

2. Fiber sharing has depended on each agency having "extra" capacity to share with other agencies.

3. Fiber sharing has come about through both formal and informal arrangements made possible by a shared vision of the efficiency and utility of building a shared network.

4. The two agencies' going hand in hand to the City Council with a joint funding request from DPW and Information Services was critical to Council approval of funding for fiber capacity. The fact that the network would benefit the Police and Fire Departments was also important to gaining support.

DISCUSSION OF KEY ISSUES

1. How are bandwidth and other fiber resources allocated?

Capacity is allocated by the agency that puts it in. Normally, each agency installs sufficient fiber to share a bundle of at least six strands. The fiber is color-coded to facilitate identification and splicing at jurisdictional boundaries.

2. What is the arrangement for O&M responsibilities?

Each agency maintains the fiber in its own right-of-way. Other agencies need to live with whatever delays there may be in repairs. As the network grows, there will be redundancy so that communications traffic can be re-routed around a break.

3. How are costs allocated?

Each agency maintains its own segments of fiber.

4. How are capacity needs determined?

Initially, DPW made a judgment to install 12 multimode and 18 single mode fiber strands. That has since been doubled at a small additional cost. DPW has been using

wave division multiplexing to accommodate multiple devices including video camera feeds.

5. How are demarcation lines established between agencies and the backbone?

Not applicable; there is no backbone.

6. How have agencies used franchise arrangements?

DPW has used a CCD franchise with the power company to install segments of the fiber network (e.g., at the football stadium), taking advantage of low installation costs in the franchise agreement.

7. Are there security issues, especially for emergency services?

None were mentioned.

8. How can cities contract with private sector firms in a rapidly changing market?

CCD has taken advantage of telecommunications companies' need for local permits to install fiber networks.

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10. BOSTON'S SHADOW CONDUIT PROGRAM

PROJECT DESCRIPTION

Boston's "shadow conduit" program has created an infrastructure of conduit available for City use, reduced the frequency with which private contractors dig up city streets, and produced revenue for the City of Boston.

Boston's policy requires that telecommunications and electronics companies notify other firms of their intention to dig beneath the city's streets. Other firms that need to install conduit then become "participating" companies in the lead company's project. The street is then dug up once instead of multiple times. Any telecommunications company that fails to participate is precluded from digging in the same location for a period of time.

Projects are cleared through the Public Improvement Committee, which is composed of agencies with responsibilities from one curb to the other. The committee is chaired by the Public Works Commissioner. Instead of paying a fee to the City, telecommunications and electronics companies are required to install for City use a 4-inch pipe with four interducts. Companies must give the conduit to the City and maintain it as well. (Companies also maintain conduits for the other "participating" companies.)

Thus far, the City has obtained about 25-30 miles of conduit through the shadow program. The primary use to date is to rent interduct space to other private entities. One interduct is saved for future City use. The intent is to connect various City agencies including schools, Fire and Police. Fiber for City use has been installed in about two miles of conduit thus far. The Public Improvement Commission will centrally coordinate pulling fiber in the shadow conduit and allocating costs and bandwidth.

LESSONS LEARNED

1. City control of the right-of-way on City streets can be used to leverage a significant amount of conduit for use by City agencies.

2. The eventual network does not need to be fully planned out before the City begins to develop conduit capacity for eventual installations.

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