Houston-Galveston Area Council (H-GAC)
Regional ITS Architecture and Website Update

SUBJECT: H-GAC Communications Scan White Paper
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PREPARED BY: Kimley-Horn and Associates, Inc.

1 INTRODUCTION

This white paper documents existing and planned fiber optic communication locations that were identified as part of the H-GAC ITS Architecture Update. Information for the communications scan was collected between June 2024 and September 2024 as part of the stakeholder outreach being conducted for the H-GAC ITS Architecture Update. In addition to the information and map provided in this white paper, a fiber optic cable communications map for the H-GAC region was developed using ArcGIS. A map package with shapefiles of all fiber optic cable has been provided to H-GAC.

The information collected was based primarily on a series of interviews that were conducted with stakeholder agencies located in the H-GAC region, including counties, cities, regional, and state agencies. Each stakeholder was asked if they had fiber optic cable communication existing, under construction, and/or planned to support their transportation network. Documentation on the location of their fiber optic cable was requested. All agencies that participated in the interviews conducted between June 2024 and September 2024 are shown in **Table 1**. In addition to the interviews, a scan of fiber optic communication documentation for the H-GAC region was also conducted to identify location for fiber if documentation was not provided directly from an agency.

Table 1: Stakeholder Agencies Participating in ITS Architecture Update Interviews

H-GAC Counties	H-GAC Cities	Regional and State Agencies
Brazoria Chambers Fort Bend Galveston Harris Montgomery Waller	Baytown Galveston Houston League City Missouri City Pearland Sugar Land	Brazos Transit District Harris County Transit Harris County Toll Road Authority (HCTRA) METRO Port Freeport Port Houston TxDOT Beaumont District TxDOT Houston District The Woodlands Regional Transit Authority

2 EXISTING COMMUNICATIONS

Within the H-GAC Region, most agencies operate one or more of three different types of ITS communications: fiber optic cable communications, cellular communications, and radio communications. These different types of communications are most commonly installed to support the communication with field infrastructure (including traffic signal systems, closed-circuit television (CCTV) cameras, dynamic message signs (DMS), traffic data collecting devices such as microwave and radar detection, and toll equipment.) Communication systems are also used for intra-agency communication between departments that are not co-located but need to share data, and inter-agency communications. **Table 1** provides advantages, disadvantages, and best practice for each ITS communication type.

Table 2: ITS Communication Overview

ITS Communication	Advantages	Disadvantages	Best Practice
Fiber Optic Communications	• Advanced data transfer capabilities • Transmits large amounts of data over long distances • Can be installed while constructing roadways as a small percent of a project	• High cost when installed as a stand-alone project in urban areas	• Urban areas • Installed as part of roadway construction projects
Cellular Communications	• Cost effective for simple applications such as device monitoring and control	• Susceptible to regional power outages • Requires re-occurring costs	• Isolated locations with cell coverage • Short-term solution
Radio Communications	• Cost effective • Transmits data, voice, and video over long distances	• Requires line of sight • Unique maintenance skills required	• Rugged terrain • Bodies of water • Remote locations

Fiber Optic Communications

Fiber optic communications have proved to be the most reliable form of communication for ITS deployments. ITS relies on fast and reliable transmission of large amounts of data and video, and fiber optic cable provides the necessary bandwidth and speed to support these requirements. Fiber optic cable uses light to transmit data and video, allowing for greater data transfer rates and video capacity compared to other types of communication. This high-speed communication is essential for real-time monitoring and control of traffic, as well as for transmitting data between vehicles, infrastructure, and traffic management centers. Fiber optic communication is also highly reliable and resistant to electromagnetic interference and signal degradation. This ensures consistent and uninterrupted communication between different components of the transportation system. Fiber optic communication is a popular type of communication due to its data transfer capabilities, resistance to electrical interference, expandability, flexibility, and continually improving “end” treatment.

With more ITS infrastructure being deployed in the H-GAC Region and the emergence of vehicle-to-infrastructure technologies which also require high-speed communication, communication bandwidth needs are expected to continue to grow. Stakeholders generally agreed that fiber optic communication was the best suited technology to meet this need. It is recommended that fiber optic communications be installed in urban areas and when constructing or rehabilitating roadways or drainage systems as a small percentage of the overall project cost.

A map of the existing fiber optic cable installed in the H-GAC Region to support the transportation system is included in **Appendix A**. An ArcGIS map package with shapefiles of all fiber optic cable shown in the map in **Appendix A** has also been provided to H-GAC. Total mileage of fiber optic cable for each agency in the H-GAC Region is included in **Table 2.**

Table 3: Existing or Under Construction Fiber Optic Cable Deployments

Agency	Fiber Optic Cable Deployments
City of Houston	136 miles
City of Pearland	51 miles
Harris County	305 miles
Harris County Toll Road Authority	68 miles
Houston METRO	99 miles
Medical Center	13 miles
Rail Companies	9 miles
TxDOT Houston District - Existing	690 miles
TxDOT Houston District - Under Construction	31 miles

Cellular Communications

Cellular communications are widely used for ITS as cellular is reliable and cheaper than installing fiber optic communications. Cellular communications refer to the use of cellular networks for transmitting data to provide real-time connectivity, allowing for the exchange of information such as traffic conditions, vehicle status, and navigation data. This enables enhanced traffic management, improved safety features, and the implementation of advanced applications. Cellular networks offer wide coverage as they do not have to be physically installed along roadways, making them a viable option for supporting the communication needs of ITS.

Cellular networks do have several limitations. They have limited bandwidth capacity compared to fiber optic communication, which can result in slower data transmission speeds, especially during peak usage times. The slower speeds can impact the quality of video, both in terms of clarity and reliability of the video. Cellular networks can be more susceptible to signal degradation and interference, which can affect the reliability and quality of communication. This can be a concern in transportation systems that require high-speed and reliable data exchange. Finally, during very peak periods such as during a major incident or evacuation, cellular networks can become overwhelmed with users and transmission speeds can be greatly reduced. Most cellular providers can prioritize usage by agencies that require the cellular network for public safety reasons to help alleviate this last concern, however the networks could still slow down during times when they are needed the most. Cellular communication should be used in remote, isolated, and access-limited locations or as a short-term solution.

Radio Communications

Few agencies within the H-GAC Region still rely on radio communications. Radio-based communication networks were commonly used during the initial deployment of ITS technologies, but as cellular communications became more reliable and fiber optic communication availability expanded, many agencies began to phase out radio communications. Radio communications have limited bandwidth capacity compared to fiber optic cable, which can result in slower data transmission speeds. Radio networks are also more susceptible to signal degradation and interference, which can affect the reliability and quality of communication. Radio communications require line-or-sight, frequency analysis, and radio path survey prior to design. The maintenance of radio communications requires a unique skill set along with unique equipment, which is usually outsourced.

Agencies within the region are generally transitioning from radio-based technologies to cellular communications. None of the agencies interviewed as part of the H-GAC ITS Architecture Update indicated any plans to deploy new radio communications systems. Radio communications should be used in rugged terrain, across bodies of water, and in remote areas.

3 FUTURE FIBER OPTIC COMMUNICATIONS DEPLOYMENTS

In discussions with agencies during the update of the H-GAC ITS Architecture Update, nearly every agency expressed a design to deploy or expand their fiber optic communications network. Cost was usually identified as the biggest barrier to deployment, although several agencies were considering fiber-sharing opportunities to partner with other agencies and share access to fiber which is generally a lower cost solution then deploying fiber for a single agency to use. Agencies were asked to share any plans for locations of future fiber deployments, but only the TxDOT Houston District had specific locations identified for deployment of fiber (all of which were currently under construction.) The locations where the TxDOT Houston District is currently deploying fiber optic cable are also included in the map in **Appendix A** and the ArcGIS map of fiber provided to H-GAC.

On June 29, 2022, the TxDOT Executive Director issued a Statewide Traffic Management Systems Policy memo that included a policy directing districts to install fiber optic cable during construction on all Tier 1 Roadways if fiber is not already present. TxDOT also released a Fiber Optic Cable System Expansion strategy. The strategy aims to deploy a robust communications network along state-owned routes to facilitate current and future ITS investments by providing a high-speed communications service to the operating TxDOT District.

TxDOT also launched the Broadband Program in 2023, which is responsible for administering the agency broadband program. The TxDOT Broadband Program provides access to right of way (ROW), maximizes resource sharing, assists statewide broadband initiatives, and fosters TxDOT broadband capacity. The goal of it is to connect all of Texas through fiber. Through the Broadband Program, TxDOT has started installing conduit duct banks during compatible highway construction projects and is expanding capacity by permitting or leasing conduit and fiber.

Most agencies noted that cellular communication is still important due to the low cost for implementation and ability to quickly stand up a cellular communication system where ITS is needed. For temporary applications, such as a temporary CCTV camera installed during construction, cellar equipment can be reused at other locations once the original application is no longer needed. Given the cost of deploying fiber optic caber, particularly in urban environments with limited right-of-way available, the use of cellular communications is expected to continue because full deployment of a fiber network may be more than a decade or longer away for many agencies in the H-GAC Region.

As agencies in the H-GAC region continue to deploy ITS and rely on real-time information for operations, a robust and reliable high-bandwidth communication system will be a critical component of the transportation system. All agencies interviewed recognized this need and saw fiber optic communications as the solution best suited to support ITS deployments. Continued investment in the fiber network within the H-GAC Region will be important for the Region to fully recognize the benefits of ITS and support a fully integrated system that is not limited by band-width capacity constraints.

4 CASE STUDY

The construction of the City of Pearland's fiber network began 14 years ago. The initial goal was to connect buildings housing essential City services, such as City Hall and the Fire Department, through a high-bandwidth and reliable communications system. As fiber coverage expanded, the City realized the benefits of integrating City buildings and infrastructure together, prompting a more aggressive deployment of additional fiber.

The primary challenge with the previous radio network was its reliability. Radios rely on line-of-sight communication, which can be disrupted by new building construction or tree growth over time. Additionally, radios do not provide the same communication speed as fiber, limiting the quality of high-bandwidth data such as video from high-definition CCTV cameras.

To accelerate fiber deployment, the City of Pearland targeted fiber conduit installation on all new roadway construction and roadway rehabilitation projects. This approach was cost-effective and less disruptive since it did not require new construction. At a minimum, the City deploys empty conduit during construction, but often includes fiber, given its relatively low cost compared to road construction.

The City created a plan to connect buildings and field infrastructure. Most of the City’s traffic signals were included, though some remote signals, where fiber may not be as beneficial for other services, will likely remain on radio networks indefinitely.

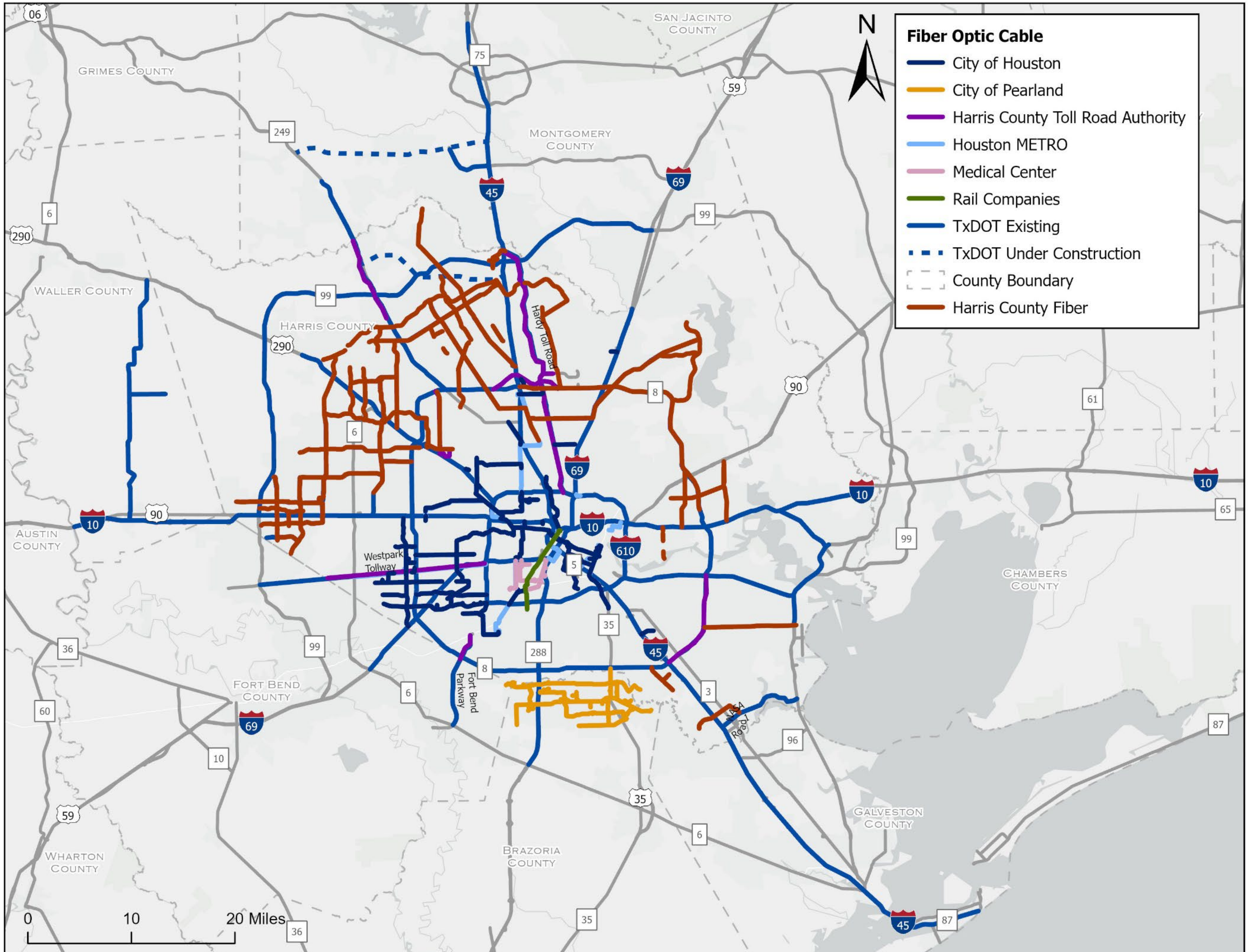
The City built redundancy into the system, minimizing the impact of future fiber damage. Over the past 14 years, there have been only three incidents of underground fiber damage and six incidents of above-ground fiber damage in the City of Pearland. Fortunately, redundant loops in the fiber system have prevented communication disruptions, highlighting the importance of a robust fiber network to the City Council.

Fiber communications have proven invaluable for the City of Pearland, especially during emergencies and severe weather events. Underground fiber is not affected by high winds, and the City has rarely had issues with floods disrupting service. The fiber network provides sufficient bandwidth and reliability to monitor and continuously record CCTV camera feeds, determine which roads are flooded, and monitor the transportation system during storms and hurricanes. The Police Department has also benefited, using high-quality video from CCTV cameras for tracking vehicles and notifying officers of their locations.

Based on their experience, the City of Pearland has learned important lessons in deploying a fiber network. They recommend prioritizing the installation of fiber conduit during all roadway projects and deploying more fiber strands than initially thought necessary for extra capacity. This approach allows for additional fiber connections and the potential to lease fiber to private companies. While the City does not currently lease their fiber to other entities, it is a consideration for the future.

Maintenance of the network is crucial, and the City allocates a yearly budget for a fiber-on-call contract to address emergencies when a fiber line is cut.

A final lesson learned is the importance of a strong relationship between the Information Technology (IT) group and Engineering and Public Works. IT is involved early in the project development process to identify if and where fiber is needed. Both groups recognize the critical role of fiber in City services, and work closely to prioritize fiber deployments and maintain a robust and reliable communications system within the City.


Fiber Optic Cable
City of Houston
City of Pearland
Harris County Toll Road Authority
Houston METRO
Medical Center
Rail Companies
TxDOT Existing
TxDOT Under Construction
County Boundary
Harris County Fiber
N
Grimes County
San Jacinto County
Montgomery County
Waller County
Harris County
Austin County
Fort Bend County
Chambers County
Galveston County
Brazoria County
Wharton County
Westpark Tollway
Hardy Toll Road
Fort Bend Parkway
0
10
20 Miles