CITY OF FRESNO, CA

Broadband Strategic Plan

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Magellan ADVISORS

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. Executive Summary

The City of Fresno is a forward-thinking city and has a desire and obligation to help its residents, businesses, and stakeholders access high-speed broadband and the technologies that use it. The Internet of Things (IoT) is transforming the way cities access and utilize technology for the benefit of the community. Formerly only major technology centers and major markets were supported with broadband; now all of America is now relevant in the world economy, and fiber optic networks are bringing the world together and allowing all communities the ability to attract and retain high-end technology jobs, reduce commutes for its residents, and attract large companies and new housing developments. IoT helps individuals with technologies support telehealth and distance learning. Smart City applications are becoming more commonplace through the use of smart traffic controls, parking availability apps, smart building controls, and security monitoring,

There are a few telecommunication incumbents in the Fresno area that, during interviews, expressed an interest in partnering with the city to expand their networks to areas that are not currently served with high-speed internet. AT&T covers the entire city with different types of technology: DSL (digital subscriber line), some fiber to the home (FTTH), and is in the process of upgrading the DSL areas to fiber. Vast Networks (CVIN), is also very interested in continuing partnerships with Fresno to expand service to areas that are difficult or challenging to build. Fresno has a fairly expansive network that can be leveraged to bring in private investment and meet the goals of the city: to produce a future proof network for the betterment of the city and the region.

The Middle-Mile Broadband Initiative (MMBI), formerly called the Golden State Middle Mile Network, is a planned state-owned network that will add a level of connectivity never seen in California but is still in the design stages. The MMBI will connect the state of California allowing for municipalities to more efficiently access points of presence and data centers across the state, and ultimately anywhere in the world. These connections are giving all areas of California the tools for economic development to attract companies and employers that can remain connected to any network in the world through the internet.

Fresno is well-positioned to leverage its existing public assets, secure state and federal broadband grants to expand its network and utilize the future MMBI in order to meet its municipal and community needs in the 21st Century. This report analyzes the region's public and private fiber assets, researches the current market and services, and identifies the gaps that exist. It then evaluates different business models and potential partnerships, proposes a conceptual network design and projected costs, and makes key recommendations on next steps.

RECOMMENDATIONS

Summary of conclusions and recommendations:

1. **City Broadband Oversight Committee**. Form or designate a committee tasked with broadband advancement and decision-making powers. Create roles and responsibilities, including taking the lead working with local, county, and regional stakeholders for cooperative broadband development and deployment. The committee should research, analyze and advise the City on broadband opportunities and policies, and work to refine workflows and policies that encourage private investment in broadband infrastructure.
2. **Apply & Secure Grant Funding For Phase 1, Pilot Area 1 & Pilot Area 2.** Research and apply for state and federal grants to aid in the planning, design, and construction of fiber assets, particularly grants that target underserved areas and development zones.
    a. **Local Agency Technical Assistance (LATA) –** The City of Fresno was recently awarded the LATA grant in the amount of $496,874 to conduct planning work in preparation for new broadband deployment. The City will utilize the LATA grant funding to complete the full design engineering for Phase 1, Pilot Area 1, and Pilot Area 2.
    b. **SB 156 Last Mile Grant Funding –** Completing the design engineering through the LATA grant will allow the City to submit a competitive grant application for project construction funding through the California Last Mile program, anticipated to be released in late 2022/early 2023. The Last Mile grant program targets un- or under-served areas, such as Pilot Area 1 & Pilot Area 2, as well as the required backbone fiber network to serve those areas.
3. **Connect City 10 City Sites Not Currently Served.** The City identified 10 parks that currently have no broadband service; the High Level Design in Section 6 proposes network expansion to connect these 10 sites into the City's fiber network.
4. **Establish a Data Center**. Offer the space at the historical Bee Building at 1555 Van Ness Avenue or the DPU O&M Building complex at 1626 E Street, including through the Golden State Network/Middle-Mile Broadband Initiative, as a data center/colocation building for a Fresno connection point.
5. **City Policies & Standards.** Create workflows and city policies that aid and encourage broadband infrastructure development through dig once policies, updated construction standards, developer agreements and requirements, joint builds on CIP projects, and any other policy needed to further broadband. These policies should be applied to the private and public sectors including any work being performed in the public-right-of-

way (PROW). Ensure incremental fiber builds during City-wide projects by creating a mechanism to ensure new builds are fully funded before the incremental build opportunities arise.

6. **Solicit and Nurture Partnerships.** Continue partnership discussions with incumbents and local ISPs, creating a positive environment for unhindered broadband expansion. Solicit new partnerships by leveraging city fiber and conduit infrastructure to connect City facilities and encourage private expansion into underserved areas.
7. **Create a Formal Partnership with the County**. Explore formal partnership structures with Fresno County, who is simultaneously undertaking their own broadband strategic planning process, including possibly establishing a Joint Powers Authority (JPA) that can act as a single lead in grant applications and coordination efforts. Interconnecting County facilities within the City of Fresno to existing City facilities will ensure not only significant cost savings, but create a coordinated, robust, and redundant communications network for public safety, emergency operations, and regional planning.

2. Introduction

The purpose of this plan is to improve connectivity across the City of Fresno to support digital inclusion, municipal operations, and tech-oriented economic development. The City seeks to attract and facilitate private investment as well as make public investments where necessary to address community priorities. To these ends, this plan includes an assessment of existing assets and the local broadband market to identify major gaps. It reviews prospective business models for addressing the gaps, meeting current needs, and positioning for future growth. A conceptual network design reveals the general costs involved to connect city sites and provides a means to estimate revenue potential.

CITY OF FRESNO'S GROWTH PRIORITIES[1]

The City of Fresno recognizes the importance of broadband and related infrastructure. Inclusivity is very important for the City. Incumbent providers focus on profitable areas rather than under-served areas. Connectivity costs are high and keep rising. There is a lack of competition as well as slow and unreliable services. Broadband is a necessity, not a luxury, particularly for schoolwork and work-from-home. Therefore, the City wants to focus on areas that do not have broadband, and/or areas with low speeds or few options. These seem to be un- or under-served areas in the City's east, including greenfield developments, in the city center, and to the south and southwest. The City wants to leverage its investments to take advantage of all providers' strengths and ensure there is no exclusivity.

Fresno is the hub of the San Joaquin Valley, the U.S.'s most productive agricultural area, so it is important for the City to support that sector. That said, the City expects its economic growth to be in technology sectors, which leaders understand will necessitate additional housing. Agricultural technology is a particularly promising sector. City leaders feel a critical mass of such firms and a workforce will be necessary for substantial local growth to occur in this sector. Fresno also seeks to be the prime entertainment and recreation destination in central California, capitalizing on proximity to three national parks and transportation assets, including the Fresno Yosemite International Airport. Fresno encompasses approximately 130 square miles, but has room to grow, and so could expand to 160 square miles.

[1] Information in this section comes directly from interviews with City of Fresno leaders. It is not based on the opinions or views of Magellan Broadband.

Downtown revitalization is a major focus for the City. Connectivity is critical, especially as residents typically under the age of 40 who are very engaged in technology are moving Downtown from areas like Silicon Valley. The City is seeing an influx of remote workers and is incentivizing them to come, but it can be difficult to attract them without superior connectivity. Leaders want to merge broadband with new City infrastructure downtown. Key corridors that were historically commercial, particularly Blackstone Avenue, Kings Canyon Road, and Ventura Street are being converted to mixed use. Key areas, specifically Blackstone between Olive and Shields, are being redesigned to be more pedestrian-friendly. The City is 36,000 affordable housing units short of state-mandated levels, but the City expects to meet these levels by developing smaller 400 to 600 square foot units.

The City itself has substantial network assets, but also is challenged with growing connectivity needs. For example, there are 21 fire stations, including the airport, each with 10 to 15 staff, and the City plans to add five or six more, all of which need connectivity, as does the new fire training facility. The stations currently have 100 Mbps connections but need higher speeds. The Police Department has five district stations, each with 60 to 70 officers, a separate location for evidence and records, and will build a new headquarters within 10 years. Police operations use even more bandwidth than Fire. The City does not have a permanent Emergency Operations Center location, and the mobile EOC struggles with connectivity. The water treatment plant, Fire Station 19, and several other City sites do not have any fiber connections.

The City has 150 cameras, with traffic and security cameras on buses that connect via unreliable wireless connections, while other cameras are connected with fiber. First responders require mobile connectivity, which is provided by AT&T FirstNet, but use land-mobile radio (LMR) as primary means of communication. City personnel contend that both cellular and LMR had substantial gaps within Fresno; the airport and Edison areas were specifically noted. There have been a few 5G cell sites established in the area, but not enough to close the gaps. These are just some examples of how network infrastructure and services are unable to meet the needs for growing municipal operations, and how private services are not effectively meeting the City's requirements.

A recent technology master plan for the City suggested the goal of "fiber city-wide to improve City communications and to extend broadband Internet access across the City to encourage and support economic development, education,

and improve public access to City services and information."[2] That plan also noted the need to accommodate small-cell wireless infrastructure. Wi-fi in public spaces is a starting point for increasing connectivity in Fresno. The City has a trial program for Wi-Fi in buses, which works via cellular backhaul, and there has been a push for Wi-Fi in parks.

Demographics are important to broadband planning. The Fresno area population has consistently grown over 1% per year, which is expected to continue, maintaining Fresno as California's fifth largest city. The City's population is relatively young, as shown Table 1. The area has lower educational achievement and incomes than the state overall, and a poverty rate nearly twice that of the state. The City has a relatively higher proportion of people working in production, sales, services, and trades, and although the largest percentage of persons were employed in management, business, science, and arts occupations, that proportion is still below the State average.

The implication of the demographics is that the City of Fresno's residents may face financial challenges in securing reliable, high-speed internet access. Based on the City's challenges with connectivity for its personnel and City sites, simple availability and quality of service are likely also issues, particularly in older, lower-income areas of town.

[2] "The City of Fresno Strategic Technology Master Plan: Final Report," November 2016, revised July 2021, pg. 56, https://www.fresno.gov/informationservices/wp-content/uploads/sites/15/2021/07/City-of-Fresno-Strategic-Technology-Master-Plan-Update-July-2021.pdf

Table 2-1. Key Demographics Compared for State and City[3]

DEMOGRAPHIC	STATE OF CALIFORNIA	CITY OF FRESNO
AGE		
UNDER 18	22.8%	28.2%
65 AND OVER	14.3%	11.6%
EDUCATIONAL ATTAINMENT		
LESS THAN HIGH SCHOOL GRADUATE	26.4%	34.7%
HIGH SCHOOL GRADUATE (INCLUDES EQUIVALENCY)	51.7%	53.1%
SOME COLLEGE OR ASSOCIATE'S DEGREE	75.9%	81.8%
BACHELOR'S DEGREE OR HIGHER	46.2%	30.4%
OCCUPATION		
MANAGEMENT, BUSINESS, SCIENCE, AND ARTS	40.3%	31.3%
SALES AND OFFICE	20.9%	22.0%
SERVICE	18.1%	21.7%
PRODUCTION, TRANSPORTATION, AND MATERIAL MOVING	11.9%	14.4%
EDUCATION, LEGAL, COMMUNITY SERVICE, ARTS, AND MEDIA	11.4%	10.8%
NATURAL RESOURCES, CONSTRUCTION, AND MAINTENANCE	8.8%	10.6%
HEALTHCARE PRACTITIONERS AND TECHNICAL	5.2%	5.5%
MEDIAN ANNUAL HOUSEHOLD INCOME	$78,672	$53,368
POPULATION BELOW POVERTY LEVEL	12.6%	23.5%

While costly, poor-quality connectivity is not a root cause of the socio-economic challenges facing the City of Fresno, abundant, fast, reasonably priced connectivity can be part of the solution. Access to education, job opportunities, and health services can be improved with broadband. Opportunities for online, remote work and for generating income as a content creator can grow with reliable access to high-speed broadband. Simple connections with distant families and friends – as well as those nearby – are made possible with broadband. More saliently, the full range of City plans for its future effectively *require* broadband. This Broadband Strategic Plan lays out options and a roadmap for building this new critical infrastructure for Fresno's future.

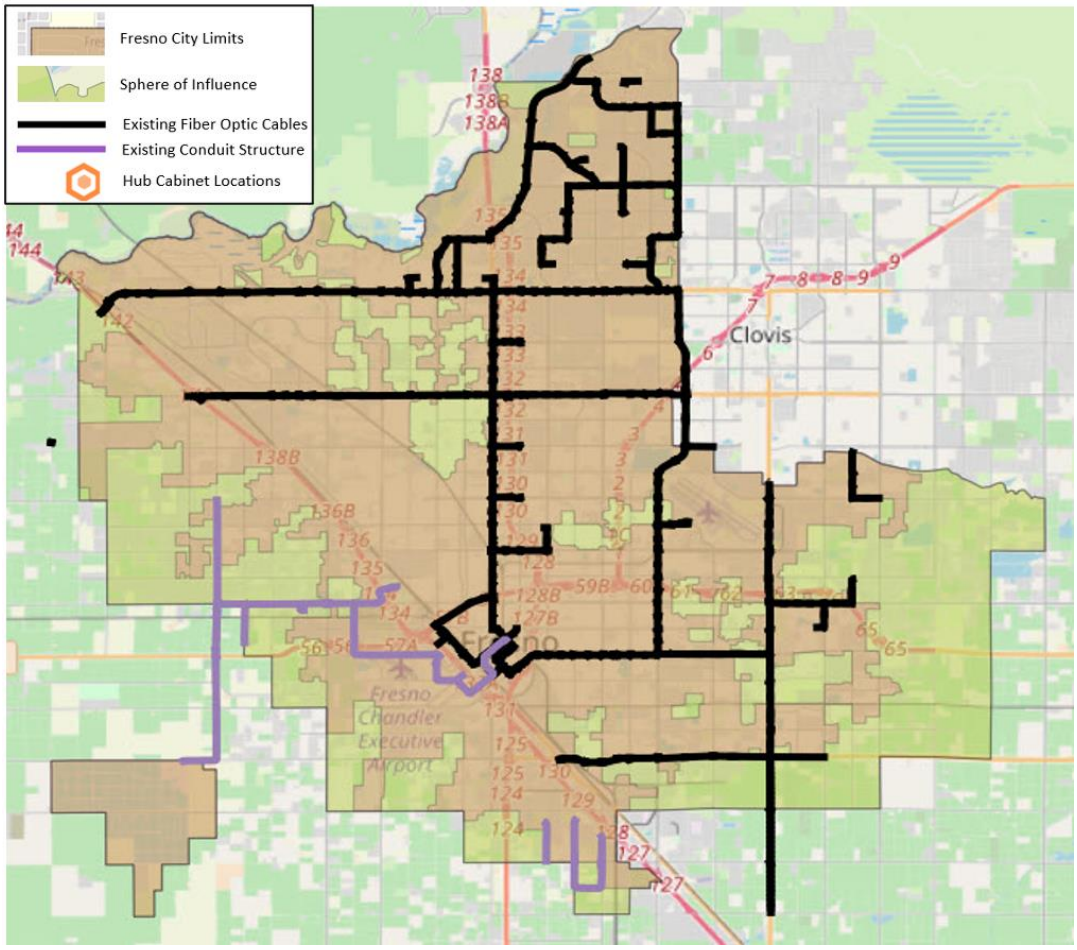
[3] US Census Bureau, *American Community Survey, 2020 5-year Estimates*, https://data.census.gov/cedsci

3. Asset Assessment

CITY OWNED ASSETS

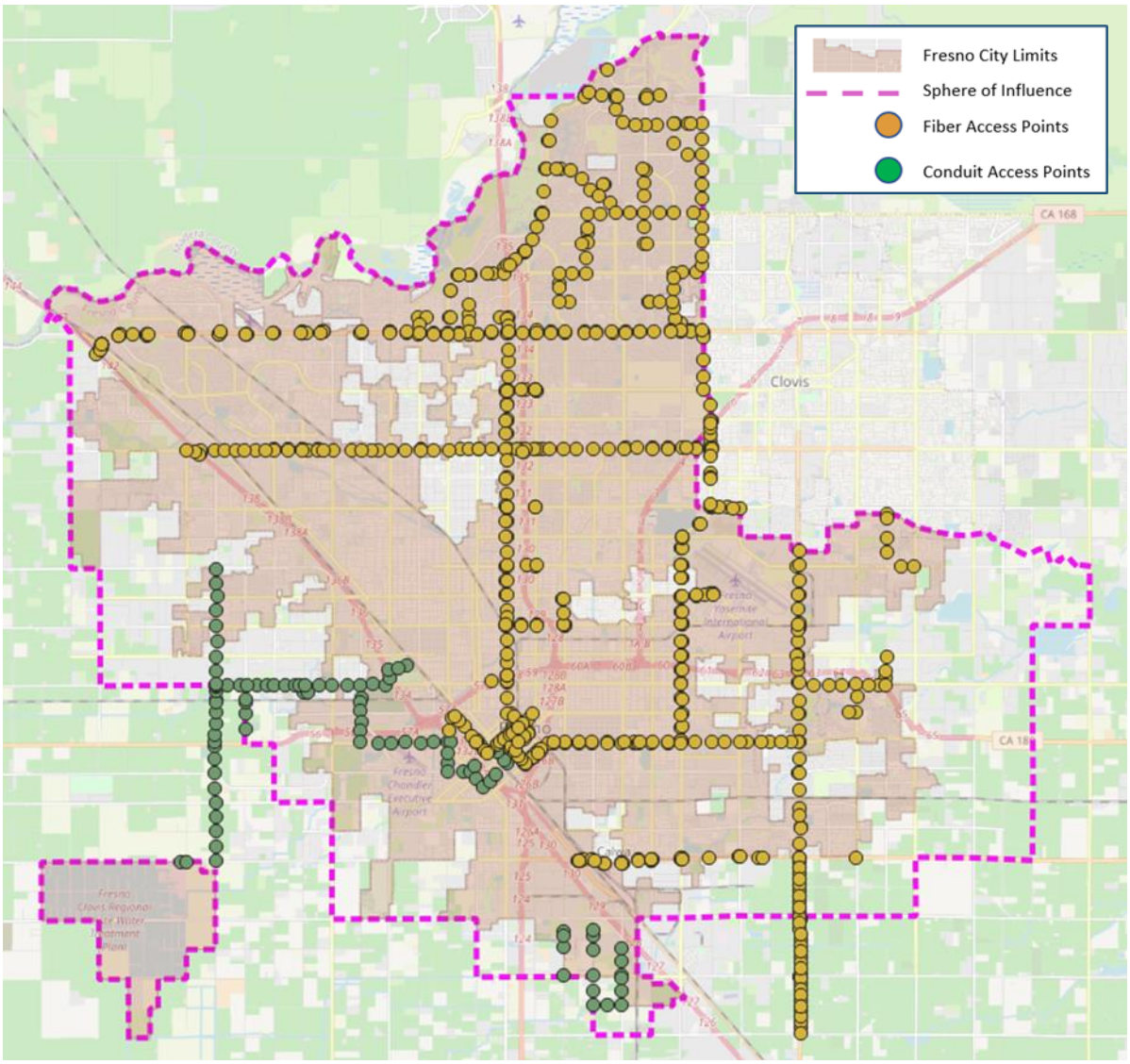
The city of Fresno owns or has right to use a relatively large amount of infrastructure that can be leveraged for advancing broadband. Fresno owns or has access to approximately 93.2 miles of existing fiber optic cables (shown in black) and about 19.8 miles of conduit placed as part of other projects (shown in purple) that can be leveraged.

Figure 1. City of Fresno Existing Cable and Conduit



A major aspect of the usability of the existing conduit and fiber infrastructure is the placement of access points in the form of handholes, vaults, or pull boxes. Figure 2 shows the location of these access points and how they allow for easy use of the existing infrastructure.

Figure 2. Fiber Access Points



NON-CITY OWNED ASSETS

Private Sector

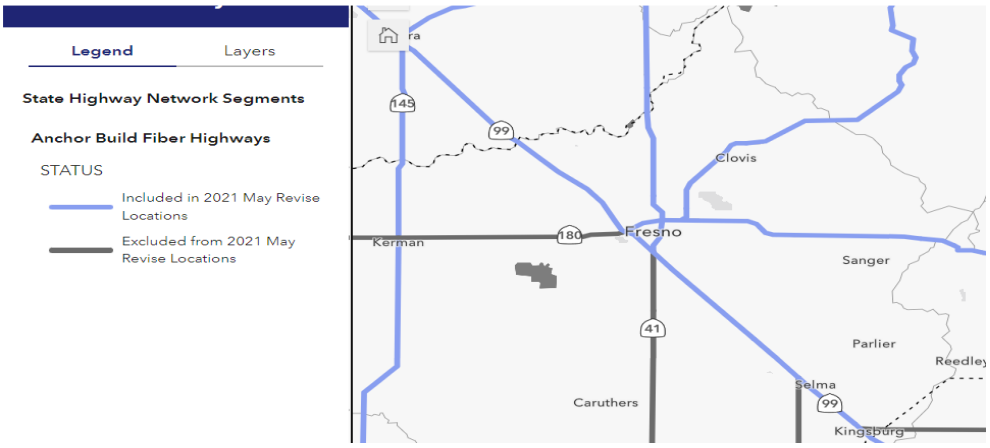
The private sector within the city limits of Fresno has extensive infrastructure, and during discussions with Magellan, it was clear that they are investing in more fiber and broadband infrastructure in Fresno. Non-disclosure agreements prevent a full accounting of the interviews; however, we believe the investment planned in the private sector is real and will greatly benefit the residents and businesses of Fresno.

There are a few sections of the City where broadband needs are not being met yet the private sector is not planning on expanding due to the high cost of construction and a lower return on investment. For these areas to be successful in supporting broadband, the City will need to create partnerships with the private sector by providing infrastructure, permitting help, and updated construction and restoration standards making the areas more profitable and attractive (see Figure 4 for a map outlining underserved areas).

Middle-Mile Broadband Initiative

Part of California Senate Bill 156 (SB 156) was the creation of a "middle-mile" network interconnecting California through a state-owned fiber optic network. The network is not fully designed and final plans for the entire network are not set; however, the portions of the network that traverse through and around Fresno will greatly aid in future broadband connectivity. The City of Fresno has a space at the historical Bee Building at 1555 Van Ness Ave or the DPU O&M Building complex at 1626 E Street that can be offered as a colocation/data center space to further incentivize and leverage matching private investment. These existing city facilities that has space available for use.

Figure 3. The Middle-Mile Broadband Initiative[4]



4. Market Assessment & Gap Analysis

[4] https://middle-mile-broadband-initiative.cdt.ca.gov/pages/data-and-analysis

INTRODUCTION

Magellan Advisors analyzed the broadband landscape of the City of Fresno to determine the available options available to residents and businesses. The analysis focused on internet speeds and pricing from commercial internet service providers (ISPs). Emphasis was on "facilities-based" carriers, or those that own physical infrastructure including fiber, copper, and coaxial cables, as well as those that own wireless infrastructure including radios and satellites. This market assessment describes findings of this research and makes observations regarding the services currently offered in the area. The conclusion of these findings supports the City making public investments and working to increase competition, which would exert downward pressure on the price of service offerings. Competition will ensure more affordable, reliable high-speed broadband options for the area's residents, businesses, and anchor institutions.

Summary Discussion

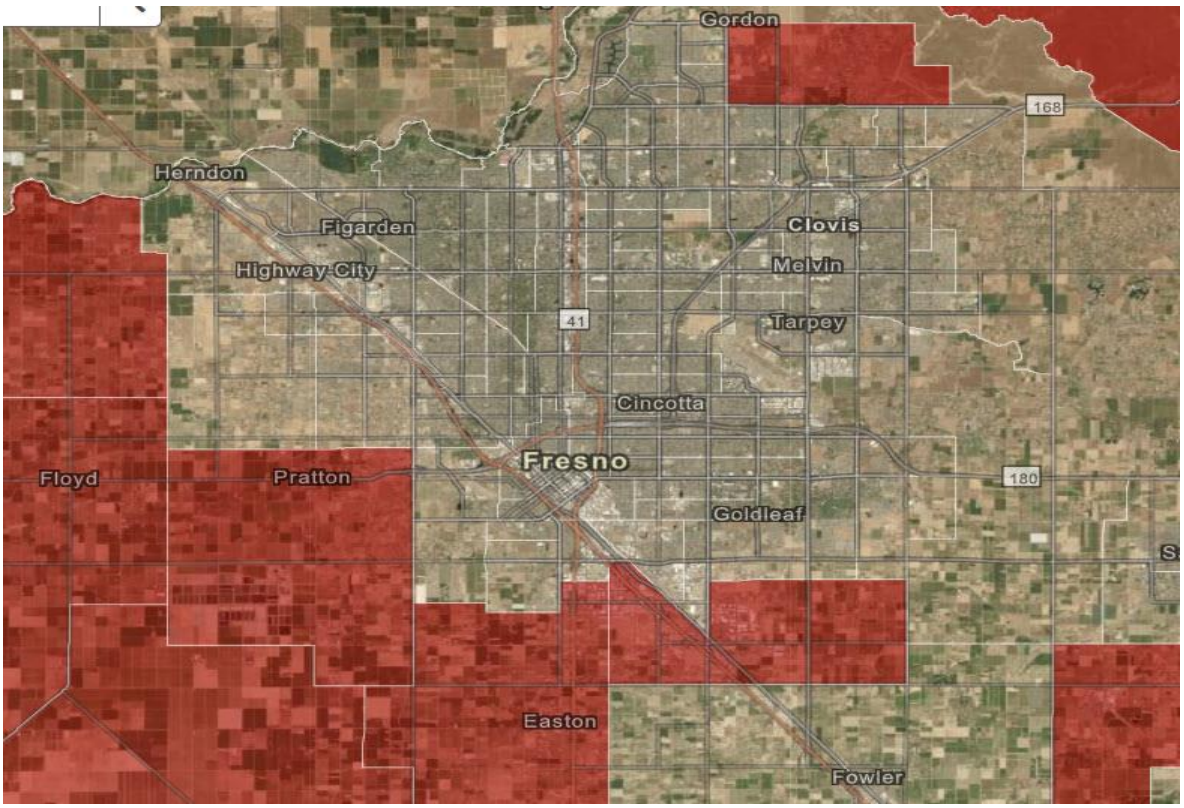
Fresno is well served according to Federal standards of 25 Mbps download/3 Mbps upload speed and California standards of symmetrical 100 Mbps download/100 Mbps upload speed. As illustrated on the NTIA underserved map (Figure 4) and on the California Broadband Map (Figure 5), almost the entirety of the City of Fresno has a gigabit offering.

However, over 80% of the City has no competition for high-speed broadband services; the only gigabit provider is Comcast-Xfinity. In about 20% of the city, there is an alternative, competitive gigabit provider - AT&T - that has a fiber-based option. The majority of the City only has outdated AT&T DSL as an alternative.

In most cases, testing revealed speeds met the FCC minimum data rates; download speeds of 25 to 100 Mbps were common throughout the City. Achieving 25-100 Mbps over DSL indicates that AT&T has at least deployed fiber to neighborhood cabinets to form a fiber backbone. This should reduce the costs and time of a fiber to the premises upgrade.

Given the current and anticipated environment in Fresno, the City would benefit from a new full-fiber competitor, either public or private. Figure 4 shows the National Technology and Information Administration map for areas in Fresno that are below the FCC's minimum 25/3 speed.

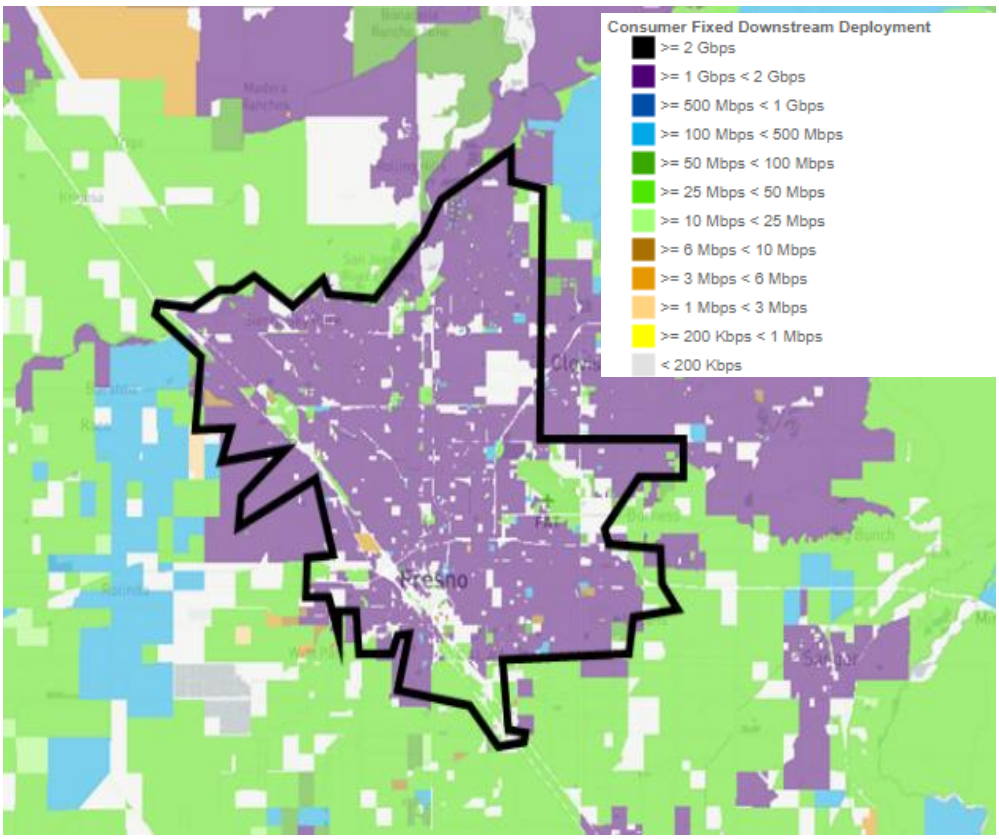
Figure 4. NTIA Underserved Map[5]



More critically, there are more dispersed areas within Fresno that do not meet the California minimum of 100/100 Mbps (see Figure 5).

[5] https://broadbandusa.maps.arcgis.com/apps/webappviewer

Figure 5. Gigabit Broadband Availability[6]



The city is fully covered with 4G/LTE by the major US providers: AT&T, Verizon, T-Mobile, and US Cellular. This competitive environment should put Fresno toward the front of the line for 5G upgrades.

FACILITIES-BASED SERVICE PROVIDERS IN FRESNO

This section will discuss the current state of "facilities-based" internet service providers serving Fresno. Facilities-based service providers own their cables, wires, cabinets and other telecommunication infrastructure.

[6] https://www.broadbandmap.ca.gov/

Comcast Corporation

Comcast is a multinational telecommunications and media conglomerate and is the largest cable TV company and internet provider in the U.S. They have over 30 million residential subscribers and 2.2 million business customers across 40 states. Their headquarters is in Philadelphia, where they've just completed a 1,121-foot addition to their existing headquarters, making the new Comcast Technology Center the tallest building in the city. Total annual revenues exceed $100 billion with approximately 65% from cable and telecommunication services. The remaining revenue is split between their other major holdings - NBC Universal and Sky (UK). Net income in 2020 was over $10 billion.

As the legacy cable TV provider in Fresno, Comcast has near 100% coverage of the city. They provide the traditional "Triple-Play Bundle" of voice, cable TV and Internet services. They have leveraged their hybrid fiber-coax (HFC) network and the Data Over Cable Service Interface Specifications (DOCSIS) standards to provide a common set of services throughout the city.

The focus of this study is on internet access only, as Magellan projects cable TV will continue to transform into primarily a streaming internet application. For Internet access services in Fresno, Comcast's recent offerings start at 50 Mbps for $20/month with a one-year agreement, which assumes a discount of $10/month for automatic electronic billing. This package includes 1.2 terabytes (TB) of data per month with 50 gigabit (GB) blocks automatically added at $10 each.

Beyond this entry level offer, their recent promotional rates were 600 Mbps, 900 Mbps and 1,200 Mbps for $50/mo., $60/mo., and $70/mo. respectively. These rates are guaranteed for 24 months with a one-year contract. They jump an additional $30/mo. after the first two years. These offers include a data cap of 1.2 TB per month with 50 GB blocks automatically added at $10 each.

Table 2. Comcast Offerings in Fresno

SPEED	PROMO MRC*	CONTRACT TERM	MRC TERM	MRC AFTER PROMO ENDS	DATA CAP	DATA OVERAGE CHARGES
50 MBPS	$20/mo	12 months	12 months	$50/month	1.2 TB	$10/mo per $50 GB
100 MBPS	$40/mo	12 months	24 months	$70/month	1.2 TB	$10/mo per $50 GB
600 MBPS	$50/mo	12 months	24 months	$80/month	1.2 TB	$10/mo per $50 GB
900 MBPS	$60/mo	12 months	24 months	$90/month	1.2 TB	$10/mo per $50 GB
1200 MBPS	$70/mo	12 months	24 months	$100/month	1.2 TB	$10/mo per $50 GB

**MRC –Monthly Recuring Rate*

The upstream rates are not published by Comcast. These tend to be in the 5-20 Mbps range due to inherent limitations in their Hybrid-Fiber-Coax (HFC) network architecture. For Comcast to offer significantly higher upstream rates, outside plant upgrades would be required. These include deploying new fiber deeper into each neighborhood as well as upgrading all existing amplifiers in the field.

Comcast, and the cable industry in general, has a straightforward and comparably inexpensive upgrade path or roadmap to gigabit and 10 gigabit services, including the addition of higher speed symmetrical services.

CableLabs, the research and development organization of the cable industry, has recently certified DOCSIS 4.0 with deployment expected to start in 2025. This will enable Comcast to increase aggregate and per home data rates without massive outside plant upgrades or new construction. New equipment at the centralized headend and new customer premises equipment are all that's required. The more advanced features, highest speeds, symmetrical services, and advanced capabilities of DOCSIS 4.0 do require outside plant upgrades and will likely be concentrated initially in the more affluent neighborhoods and commercial centers. Many of these requisite upgrades are part of a general planned upgrade to push fiber closer to homes and eliminate as many costly analog RF signal amplifiers and aging coaxial cable as possible.

In addition to higher speed modems, Comcast is investing in technologies and solutions to improve the overall customer experience and raise the bar for competitors and new entrants. For example, they are offering enhanced secure whole-home Wi-Fi to improve performance throughout the home and reduce Wi-Fi related call center activity.

They are also adding new consumer services to enhance their 'bundle' and increase consumer switching costs when moving to a new provider. New services include home security with 24-hour monitoring and mobile cellular

offerings. The mobile offerings are based on an MVNO (Mobile Virtual Network Operator) agreement with Verizon Wireless that gives them a Comcast-branded national wireless footprint on the Verizon Network. As of the Second Quarter in 2021, Comcast has over 3.4 million wireless customers generating over $2 billion annually in revenues.

AT&T

AT&T is the Incumbent Local Exchange Carrier (ILEC), or the legacy telephone company in Fresno. AT&T has a large ILEC footprint across the USA as well as in California. AT&T is, in reality, SBC, Southwestern Bell Corporation, which bought AT&T Long Distance years ago and kept the well-known AT&T brand name. SBC also bought fellow ILECs Pacific Bell, Ameritech and Bell South resulting in their huge national footprint.

Typically, ILECs have nearly 100% coverage and this is true with AT&T in Fresno. Additionally, AT&T has deployed fiber to the home or premises across 20% of Fresno.

Table 3. AT&T Fiber Services

SERVICE	DATA RATE	COSTS	EXTRAS
AT&T FIBER INTERNET 1000	1Gbps	$60/mo.	+$10/mo. Modem Fee
AT&T FIBER INTERNET 500	500 Mbps	$45/mo.	+$10/mo. Modem Fee
AT&T FIBER INTERNET 300	300 Mbps	$35/mo.	+$10/mo. Modem Fee

For at least 80% of the city, AT&T offers internet access over their legacy investments in DSL (Digital Subscriber Lines) technologies which enable data services over copper phone wires. The data bandwidth supported by DSL depends on the length of the copper wire and the type of DSL deployed. AT&Ts DSL offerings start as low as 768 Kbps (less than 1 Mbps) at locations such as North 6th Steet and reaches a maximum advertised speed “up to” 100 Mbps at locations such as West Lexington Avenue. 10, 25, 50, and 75 Mbps speeds were the most commonly found in Magellan’s research of AT&T DSL services in Fresno.

Although AT&T offers at least seven (7) different DSL packages with advertised speeds ranging from “up to 768 Kbps” all the way to “up to 100 Mbps,” AT&T charges the same $45/month for all DSL subscriptions, regardless of the actual data rate provided. These fees do not include the DSL modem/Wi-Fi router, which adds another $10/month “modem lease” fee, and a $10/month charge for each 50 GB of data over the cap of 1 Terabyte (TB, or 10,000 MB), making their offering even less competitive with Comcast.

These relatively fast DSL speeds of “up to 100 Mbps” imply that AT&T has deployed significant amounts of fiber to neighborhood pedestals and cabinets,

relying on copper only locally within neighborhoods for the last few hundred feet to get into the home or business. Existing fiber backbones could reduce the cost and time for them to upgrade more areas to true gigabit fiber networks.

Since the pandemic and the accompanying wide-spread realization that broadband and internet access were essential to modern life, AT&T has made numerous public statements about their goal to deploy fiber to millions of customers throughout their footprint. AT&T also has a nationwide mobile network and are deploying fiber to support towers and small cell antennas as they expand their 5G coverage.

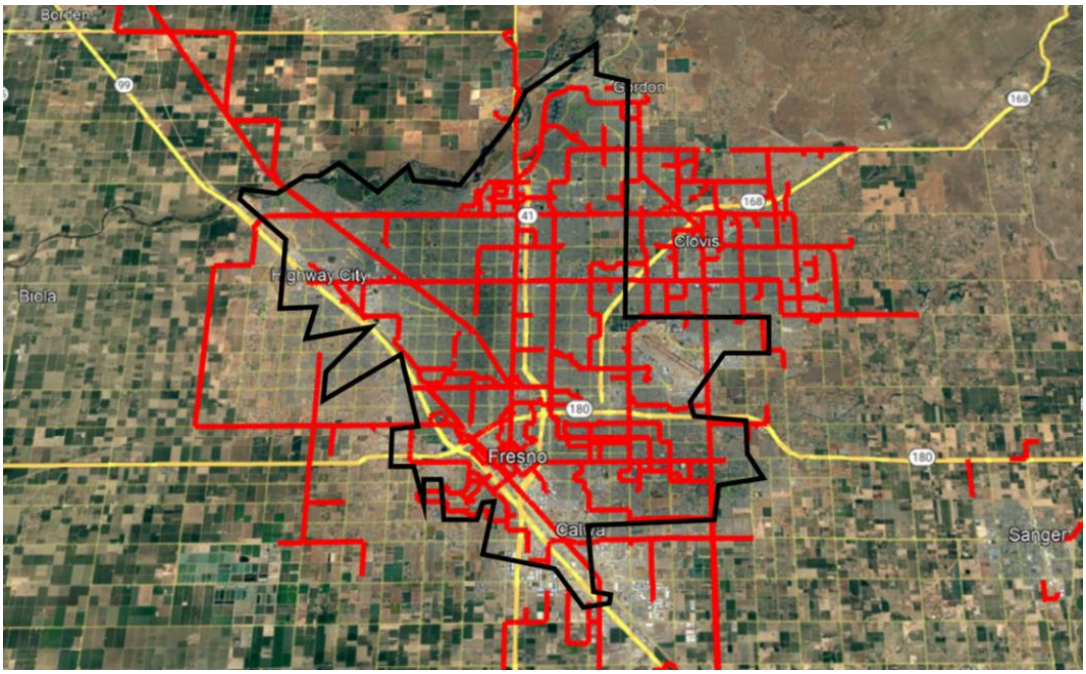
AT&T's annual capital budgets are in the tens of billions of dollars, but this is disbursed throughout their footprint, including national 5G rollouts. The challenge for Fresno is when, and where, AT&T will deploy fiber in the City.

Magellan believes that AT&T is focused on overbuilding fiber in the larger cities in their ILEC footprint, and projects that Fresno is one higher-priority regions based on the size of the residential market. During discussions with AT&T, they noted that in 2021 they added over 60 miles of fiber serving dozens of neighborhoods in Fresno. In 2022, they are targeting over 80 miles of new fiber. They also have 39 retail locations in the city, which includes AT&T Wireless as well.

CVIN/Vast

Magellan and the City of Fresno also met with CVIN/Vast, a major provider of business connectivity services. CVIN (Central Valley Independent Network) has an agreement with the City to maintain their existing fiber. It also has a dark fiber ring for the Fresno Unified School District that connects 85 schools. Throughout the central valley's 18 counties, CVIN has a 1,300+ mile fiber backbone. Their network assets in Fresno are extensive, as shown in Figure 6.

Figure 6. CVIN/Vast Network in Fresno



CVIN/Vast does not target the single-family home market; however, they do serve the large multi-dwelling unit (MDU) market and are in discussions with the Fresno Housing Authority to serve the City's public housing. They anticipate bringing gigabit fiber to some of Fresno's affordable housing developments, with the Housing Authority deploying and managing a campus-wide Wi-Fi network.

New Fiber Entrants

Given the current dynamics in Fresno, Magellan anticipates that a new fiber entrant would find the city an attractive investment and would gain sufficient market share (take rate) to achieve sustainability. A new entrant with a full fiber architecture, including ubiquitous services to residential and business premises, would create a vibrant three-way gigabit market in the City.

According to the U.S. Census Department, there are 168,800 households in Fresno. A new entrant would need roughly a 35% take-rate to achieve steady-state operations, or about 57,000 households. The neighborhoods in Fresno are dense in grid-like arrangements with 20 to 34 homes per 1,000 feet of road. This enables the fiber construction costs to be amortized over more households reducing the cost to pass and serve each one.

While the City should support and encourage new facilities-based entrants, they must ensure that the benefits reach the entire city and is not limited to the more affluent neighborhoods. The City should also be careful not to give any single entity an unfair economic advantage in the process.

Other issues with that must be addressed with private companies include, but are not limited to:

- The critical nature of fiber as civil infrastructure
- Universal coverage and deployment timing
- Cybersecurity, neutrality, and privacy
- Transfer of ownership

Summary of Feedback from Facility-based Providers in Fresno

1. All three service providers are interested in sharing construction. If the city was digging a trench along the streets of Fresno, all service providers would be interested in deploying their own conduit. This would apply to any trench (water, sewer, etc.), even if the city was not deploying their own telecommunications conduit. A 90-day notice, or longer, was requested. Comcast stated a specific interest in the downtown areas, since, as a legacy cable TV company, they lack assets in dense commercial areas.
2. Current City policies may be actually *increasing* the cost to deploy assets in Fresno: there is a City ordinance that mandates underground conduit be installed a minimum of 10 feet from water pipes. This exceeds State regulations and can add substantial costs to constructing new assets in Fresno, as well as negate opportunities for joint trenching.
3. It was noted by service providers that the restorations and moratoriums on newly paved streets can be excessive. A long-term paving schedule was requested in order to plan pre-moratorium construction.
4. The two incumbent ISPs, Comcast and AT&T, both expressed interest in working with, or partnering with, the city to address the affordability issue. Both have a low-priced offering for qualified low-income households, and both have programs built around the $30/month Affordable Connectivity Program (ACP) subsidy.
5. Educating the community on the availability of the ACP subsidy can increase the number of households connected to the internet. To be neutral and non-discriminatory, it would be worth exploring a City-led ACP educational outreach program with both Comcast and AT&T.

WIRELESS BROADBAND SOLUTIONS

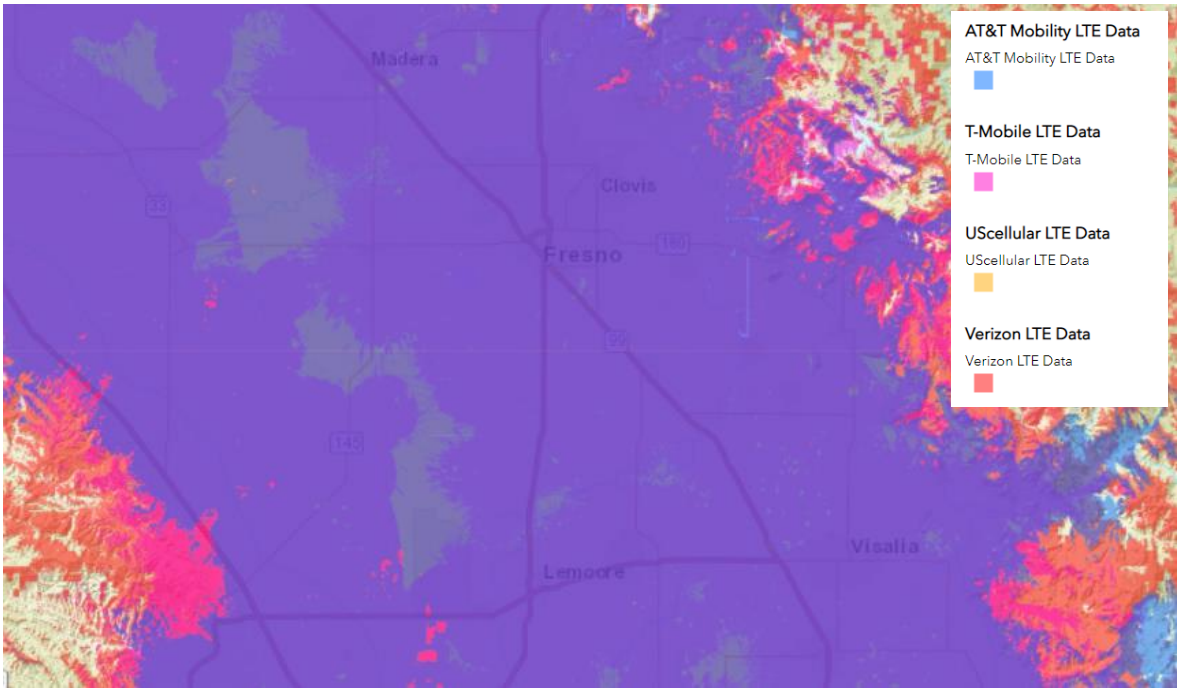
This section highlights the wireless broadband solutions in Fresno, including 4G, 5G, fixed wireless, and satellite.

Mobile Network Operators 4G & 5G

According to the FCC, the City of Fresno is well covered with 4G mobile offerings from AT&T, Verizon, T-Mobile, and US Cellular. The FCC uses Form 477, a self-reporting instrument, to assess and determine coverage areas. Although Figure 7 shows complete coverage of the Fresno area, the FCC's

disclaimer notes that “the coverage map is based on propagation modeling, a user’s actual, on-the-ground experience may vary due to factors such as the end-user device used to connect to the network, cell site capacity, and terrain.”[7]

Figure 7. 4G Coverage of all providers



Wireless Internet Service Providers (WISP)

WISPs offer internet access over a point-to-point wireless connection. These line-of-sight technologies deploy a radio antenna at the customer premises that creates the wireless radio frequency (RF) connection to a centralized antenna typically located many miles away. WISPs need to backhaul data to the same interconnect facilities that hardline fiber optic networks use – data centers in major cities like San Jose and Los Angeles. When fiber backhaul is not available, some WISPs use point-to-point wireless microwave links. WISPs currently offering services in Fresno include:

- unWired Broadband covers close to the entire city with plans starting at $60/month and speeds of up to one gigabit.
- Sebastian covers about 3.6% with 100 Mbps for $135/month.

Satellite

[7] https://www.fcc.gov/BroadbandData/MobileMaps/mobile-map-How the map was prepared.

Historically, there are two satellite internet companies servicing the entire continental U.S.; HughesNet and ViaSat. These are based on geosynchronous satellites (GEO) that orbit ~23,000 miles above the earth. Even though the signals travel at the speed of light, the 23,000 miles up and 23,000 miles down adds substantial latencies (600-700 milliseconds) and signal degradations that minimizes the effective bitrates.

There are at least two Low Earth Orbit Satellites (LEOS) constellations being deployed today. One is Starlink, from Elon Musk's SpaceX Corporation, and the other is OneWeb, a UK-based consortia. These satellites orbit the earth at altitudes of about 350-500 miles. Thus, latencies have been reduced to 30-50 milliseconds (as compared to the 600-700 milliseconds latencies of the GEO offerings). Data rates of 50-100 Mbps downstream are expected once the full constellation of satellites is launched over the next few years.

Starlink is currently in beta testing and has limited availability in most locations. Subscriber costs are $99/month with a $500 upfront charge for hardware.

Magellan does not consider GEO or LEO satellite broadband as a viable primary option for urban and suburban users. However, they could be considered as a redundant and/or back-up link for city government, businesses, or residences.

MIDDLE MILE AND EDGE DATA CENTERS

The broadband network begins at a home or business, but it does not end at the local central office or fiber aggregation point. The end of the broadband network, or the "edge," is where it connects to the internet (and also where the cloud services interconnect). These edges reside in data centers and interconnect facilities in select U.S. cities. While there are more regional data centers in Fresno or in nearby cities, the nearest major internet peering center is in San Jose, approximately 125 miles from Fresno, or in Los Angeles, approximately 210 miles way.

There are limited data centers outside of San Jose and Los Angeles. Most of those shown in Fresno, Modesto and Bakersfield are legacy Level 3 and Time-Warner inter-connect facilities. This is not an immediate concern assuming sufficient connectivity to San Jose and Los Angeles. However, the city and region should encourage and facilitate data center development over the long term.

Figure 8. Regional Data Center Locations

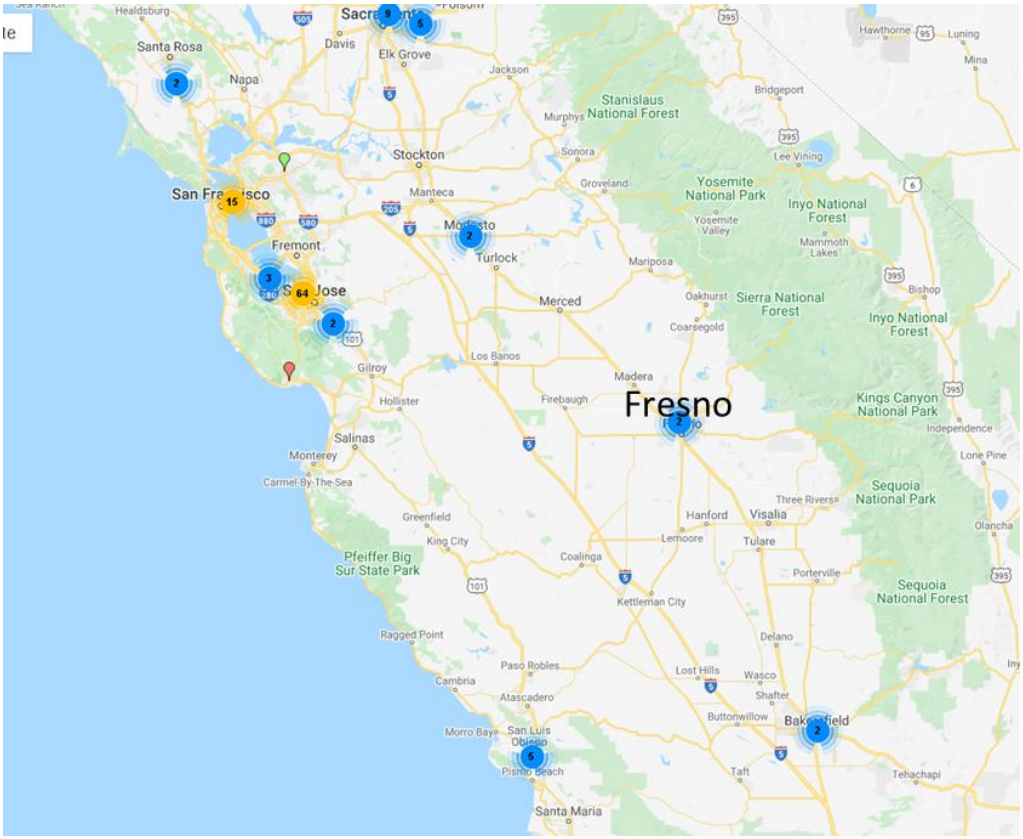


Figure 9. Local Data Center Map

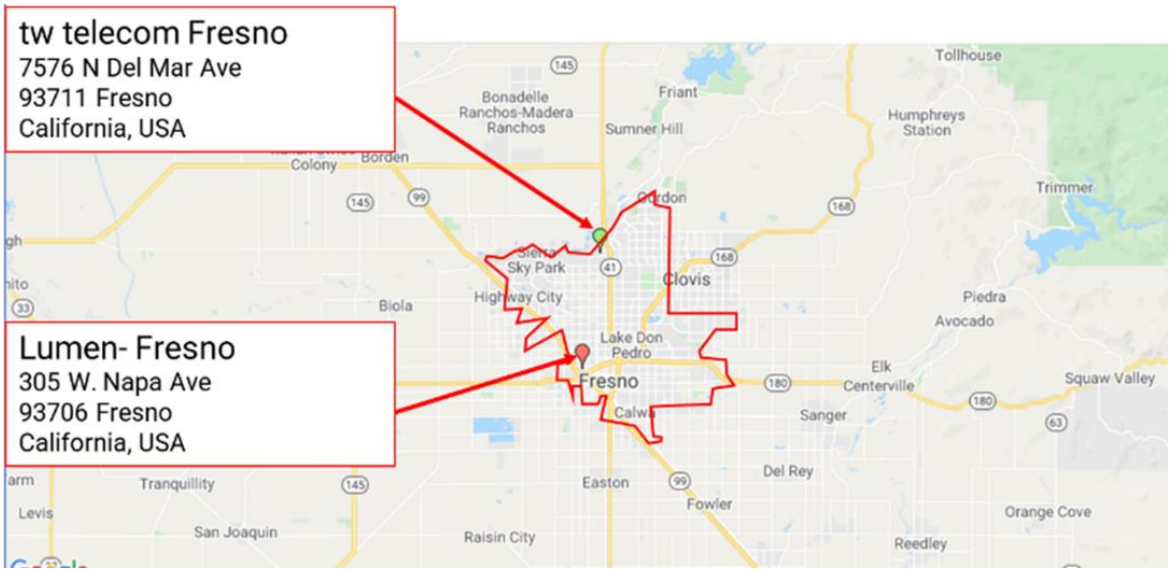
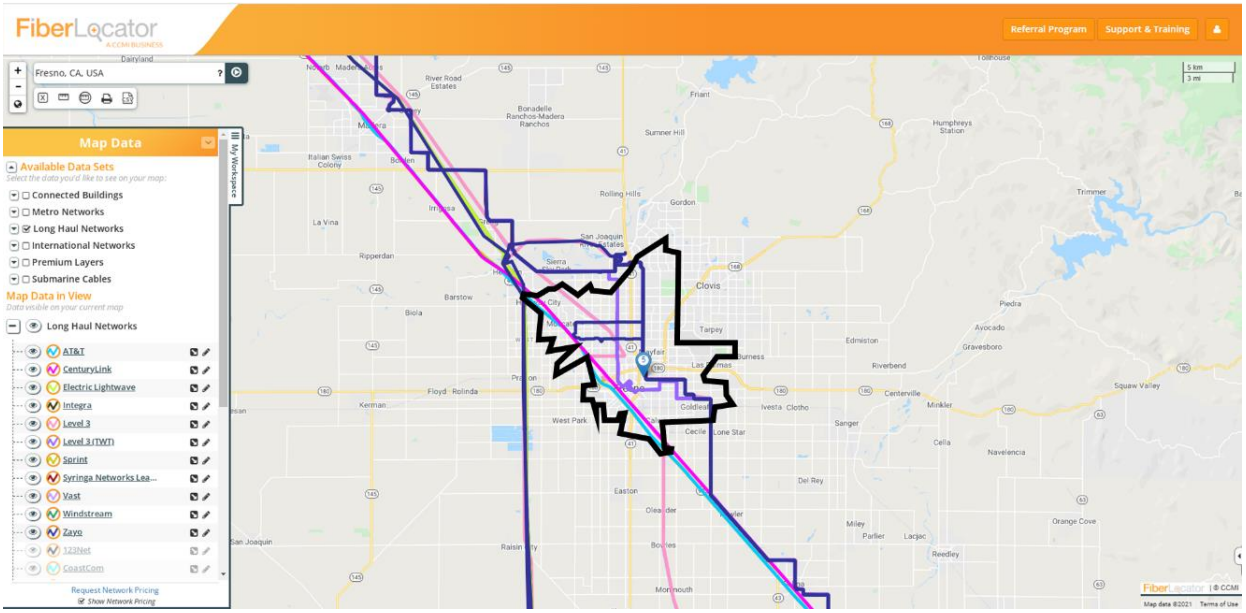


Figure 10 shows backhaul fiber that is capable of carrying data to peering centers running through Fresno along and parallel to Highway 99. There are multiple providers of middle mile fiber, as well as redundant routes to San Jose. Similarly, for redundancy and resiliency purposes, connecting to Los Angeles is prudent to ensure there is not just a single connection to the internet that can be disrupted. There appears to be abundant fiber heading to Los Angeles as well.

Figure 10. Long Haul Fiber

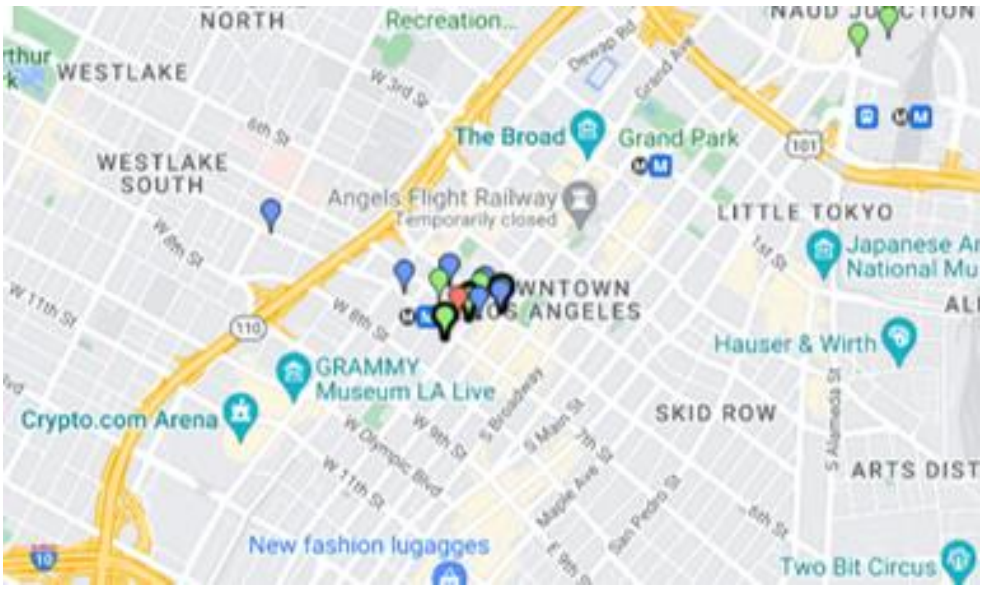


The internet peering centers in San Jose and Los Angeles are two of the best-connected centers in the world. Fresno would be well served with redundant connections to each.

A major trend in data and software applications is the migration of services to "the cloud." By moving data resources closer to the edge, end users are able to reduce latency and improve application performance. Thus, data centers and peering points are increasingly being established further from the major internet centers to enable better cloud services in areas further from major US cities.

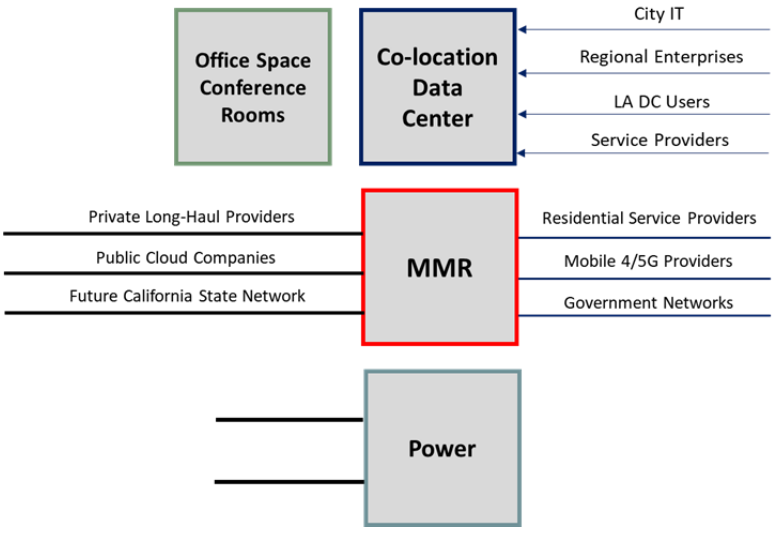
To illustrate the value of hosting a data center, these large interconnect facilities in the Los Angeles area provide an aggregation point for more than 250 service providers and cloud companies that interconnect at One Wilshire Boulevard in Los Angeles. In addition, the Meet-Me-Room (MMR) at One Wilshire has attracted a cluster of data centers in the surrounding buildings.

Figure 11. Los Angeles Data Center Cluster



The City of Fresno could benefit from the creation of a similar vibrant MMR and data center ecosystem. San Jose and Los Angeles data center users would benefit from the Fresno location for redundancy and disaster recovery. Fresno and Fresno County would benefit from having "the Edge" in the city.

Figure 12. Meet-me Room as Driver for Ecosystem Creation



Summary

The City is considered well served by Federal and State definitions since all residents of Fresno have access to Comcast. However, only 20% of the City has access to direct fiber and multi-gigabit providers. From a mobility

perspective, the City is well covered by the three major mobile network operators. There also appears to be sufficient fiber to ensure the City has redundant high-speed connections to major internet peering points.

The City should encourage incumbents to accelerate fiber deployments and encourage a new fiber entrant, public or private, to compete in the city. The City should work with all entities deploying fiber in to ensure there is sufficient infrastructure for all municipal and smart city purposes.

Fresno is strategically located and in the long term, the City and region would benefit from having data centers to ensure Fresno, and the county, are in the early deployment waves of new digital services and applications that will enable economic growth and development.

GAP ANALYSIS

Magellan analyzed the broadband market in the City of Fresno and identified four broadband-related gaps:

1. Lack of Competitive Broadband Providers
2. Lack of Data Centers and Interconnect Facilities.
3. Lack of Digital Infrastructure in the South Central Fresno
4. Lack of Internet Access Among a Portion of Fresno Households

GAP 1 – Lack of Competitive Broadband Providers

According to the FCC, the City is adequately served, as almost all residents have access to Comcast internet services with advertised speeds up to 1.2 Gbps. However, Magellan considers that 'served' should imply at least two ISPs with gigabit offerings in order to offer service options and ensure competitive pricing. Today, only 20% of Fresno with access to the second option of AT&T Fiber meets Magellan's definition of "adequately served."

The remaining 80% of Fresno has only a single provider - Comcast – for high-speed internet access. In these areas, the only competition is through AT&T DSL subscription over their legacy copper telephone network, which is only able to offer inferior data speeds of 25 to 100 Mbps . While these speeds meet the FCC's minimum definition of broadband, they are not sufficient, and do not meet the California minimum standard for high-speed broadband. As noted above, AT&T is deploying substantial amounts of fiber each year. However, Fresno is a large city, and most areas will not have competition for many years.

Comcast typically has regional pricing and will not unnecessarily increase prices in uncompetitive areas. However, facilities-based gigabit competition will drive incumbents' timing for distribution and equipment upgrades, customer service, and top-tier broadband speeds.

GAP 2 – Lack of Data Centers and Interconnect Facilities

Fresno is strategically located and there is sufficient backhaul/longhaul fiber connecting the region to the rest of the State and, concurrently, the Internet. However, despite significant fiber cables providing data transport, the City does not host many data or peering centers that can enable carrier interconnectivity and encourage entry of new carriers or private investment.

In the long run, The City of Fresno will benefit from having an interconnect facility in the city to drive the development of data center infrastructure and to participate in the evolution of the cloud and edge computing.

GAP 3 – Lack of Digital Infrastructure in South Central Fresno

South Fresno, also known as the South Industrial Priority Area, is identified in Figure IM-1 of the Fresno General Plan as a priority area that is in need of infrastructure investment. The South Central Specific Plan includes three policies that relate to "Internet Access and Computer Literacy." However, Magellan's analysis shows that this area needs the requisite digital infrastructure in order to achieve many of the other goals and policies stated in the South-Central Specific Plan and should be a top priority equal to other utilities (e.g., water, electricity, and sanitation).

Fiber should form the foundation for the area's digital infrastructure. It will facilitate the Specific Plan's stated priorities of improving quality of life, maximizing economic benefit, and reducing environmental impact.

GAP 4 - Lack of Internet Access Among a Portion of Fresno Households

Fresno residents lacking broadband access are not constrained by service availability, as the entirety of the City has access from either Comcast or AT&T or through wireless provider. Households reporting no internet access, including substantial socio-economic segments of the population (low income, seniors and the disabled) are primarily the result of financial ability and digital literacy.

The cost of digital devices such as laptops, PCs, or tablets, as well as the monthly recurring fees, can be cost prohibitive for some households and result in the lack of any internet access. Digital literacy, or the knowledge and ability to use devices to access the internet, can also deter households from engaging in the digital world – particularly senior and immigrant populations with fewer opportunities to use, learn and develop digital skills.

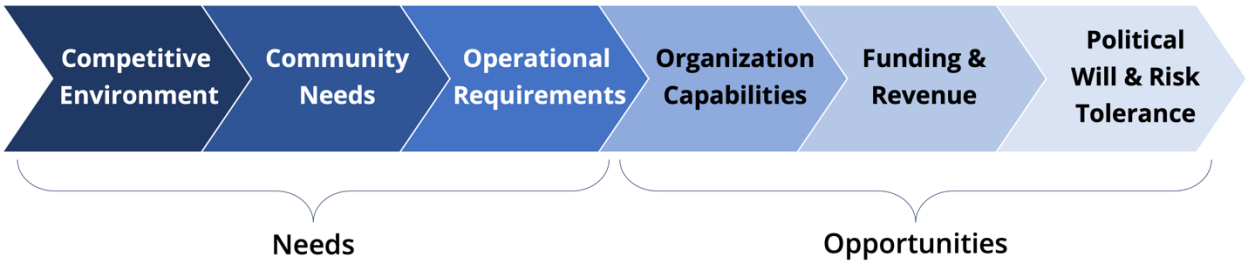
Although both Comcast and AT&T are willing to work with the City to promote federal ACP subsidies, this can only address household finances, not the digital literacy challenge. Partnering with non-profit organizations and other community-based organizations can help the City provide more training and

educational opportunities to help digitally-marginalized communities close the gap.

5. Business Model & Partnership Assessment

Cities are realizing the importance of next-generation broadband services to support the future of their communities. Evidence demonstrates that broadband services have a net positive economic and social impact to communities by enhancing competitiveness, workforce development, educational capabilities, municipal operations, and smart city deployment.

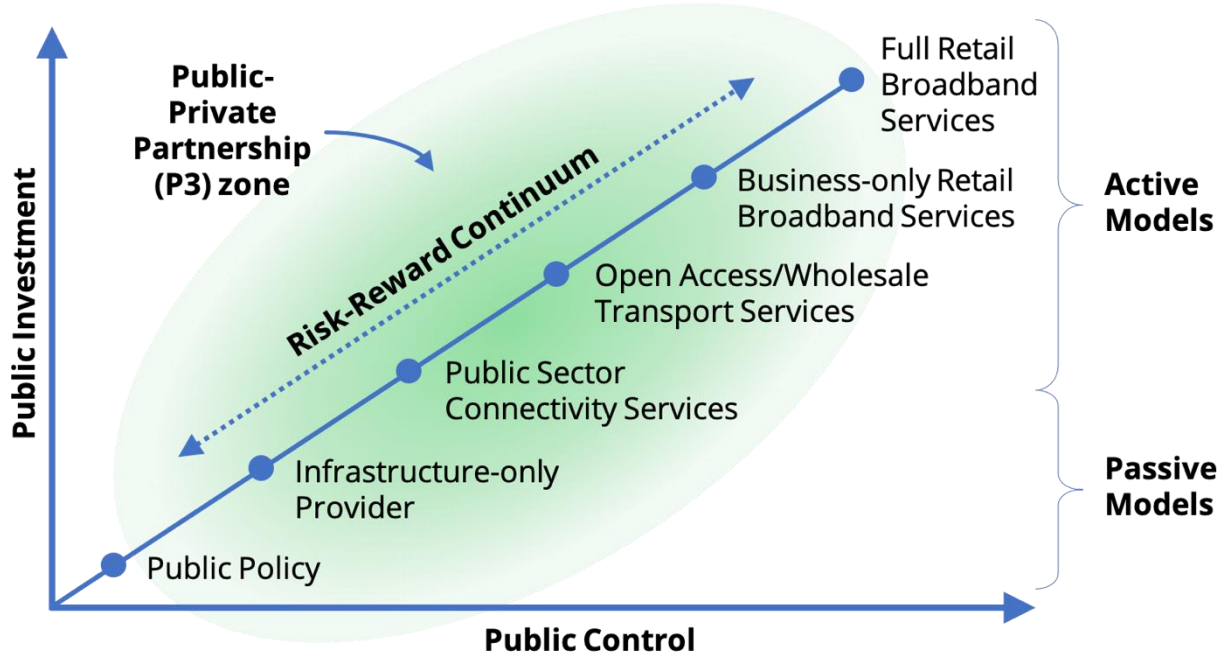
Figure 13. Factors to Consider when Choosing a Broadband Business Model



To determine which business model for municipal broadband is best, local governments should understand various factors, shown in Figure 13, such as: community needs, competitive market factors that define infrastructure options, and organizational and operational capabilities of the local government itself.

The various business models, illustrated in Figure 17, involve different levels of investment and control that come with varying risks and rewards. The City of Fresno has numerous options – from a lassie-faire, public policy-only approach all the way across the spectrum to a full retail internet business. The key factors that define a public-private partnership, as opposed to simply a customer-vendor relationship, is that: (a) all parties contribute, (b) each parties' benefits are based on their contributions, and (c) one partner does not pay another; there are few or limited transactions between partners.

Figure 17. Broadband Business Models Differing Levels of Control and Investment



BUSINESS MODELS[8]

Public Policy Only

The municipality utilizes its public policy tools to influence how broadband services are likely to develop in its community. Public policies are shaped to streamline the processes of designing, constructing, and managing broadband infrastructure in a local government's jurisdiction. Focus areas include right-of-way access, permitting processes and costs, construction practices and placement methods, franchise agreements, and utility fee assessments. Examples of broadband policies and standards include: joint trenching and "dig once" policies, utility relocations, road moratoriums, and funding mechanisms for design, labor, and materials. This option is not considered a true business model but does impact the local broadband environment and is therefore included as one option.

The key to successful policy development and implementation is inter-departmental coordination and communicating the shortcomings in current practices and policies. With a better understanding of interdependent

[8] Case studies for each business model are included in Appendix C.

responsibilities, policies can be improved. In addition, changes often come with an associated cost, so municipality will often need to establish a fund to assist in the early adoption of certain policies.

Infrastructure Provider

Cities that provide conduit and dark fiber services to local organizations are generally considered infrastructure providers. They lease these assets to community organizations, businesses, and broadband providers. These organizations use municipal fiber to connect to one another and to data centers to reach the Internet, cloud services, and other content networks. Many municipal providers who have deployed these services began by building their own fiber networks to serve purely municipal functions. As their networks grew, they realized that these networks could provide access to local organizations needing fiber connectivity.

Dark fiber is the core product of most infrastructure providers and is generally utilized by businesses and community anchor organizations in order to reduce their telecommunication expenses and achieve higher bandwidth speeds. Typically dark fiber strands are leased using a simple mileage-based price calculation to the end user. However, customers may require new construction to reach their facilities, resulting in construction costs to be incurred by the municipality and which will be charged back to customers to allow the municipality to recoup its investment.

Public Services Provider

Public services providers utilize publicly-owned fiber and broadband resources to interconnect multiple public organizations with fiber or wireless connectivity. These organizations are generally limited to the community anchors within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and healthcare providers. The majority of these anchors require substantial connectivity and often, the local government's network can provide higher capacity at lower costs than these organizations are able to obtain in the commercial market.

Open-Access Provider

Local governments that adopt the open-access model generally own substantial fiber-optic networks in their communities. Open-access allows these local governments to "light" the fiber and equip the network with the electronics necessary to establish a transport circuit to interconnect service providers with the local network.

The concept of open-access enables competition among service providers across a network that is owned by the local government. The municipality remains neutral and non-discriminatory, and is open equally to any providers that seek to deliver services over the network. Service providers lease access to the network based on the amount of bandwidth required by the end customer and an established standard rate structure and terms of service. Open-access networks generally charge wholesale rates to retail broadband providers. They publish rates for competitive service providers, charging a monthly recurring fee based on bandwidth of the service utilized or a flat fixed fee per month. Services offered may include Internet, telephone, data connectivity (transport), and dark fiber.

Municipal Retail Provider – Business Only

A common goal for municipalities that deploy broadband networks is to support local economic development needs. Local governments equip their business and industrial districts with fiber infrastructure through which they can provide cost effective, high-speed Internet and other data services to local customers.

Municipal business providers offer competitively priced Internet and communication services that are generally very competitive in the small and medium business market against other provider offerings. They compete on both price and quality, generally focused on the following value proposition, all at a lower monthly cost:

- Higher bandwidth, scalable to Gigabit speeds
- Symmetrical service, the same upload and download
- Higher quality fiber connections with less downtime and a stronger service level agreement
- Responsive local customer service

Municipal Retail Provider – Residential

Municipalities that provide end user services to residential and business customers are considered retail service providers. Most commonly, local governments offer triple-play services consisting of phone, television, and Internet services, essentially becoming an equal competitor to incumbent cable and broadband providers. As a retail provider, the organization is responsible for a significant number of operational functions, including management of retail services, network operations, billing, provisioning, network construction, and general management.

Public-Private Partnerships

Public-private partnerships (P3s) are an emerging business model that provides an innovative solution to an ongoing municipal broadband issue: how does a local government invest in municipal broadband without operating a broadband network? Generally, P3s create a cooperative platform for a local government and one or more private organizations to plan, fund, build, and maintain a broadband network within the municipality's jurisdiction. To make a P3 successful, each organization should align on negotiable agreements, which can include:

- Who has rights to access the network – is it exclusive or non-exclusive?
- What are the public and private partners' goals and how are they incentivized?
- What roles and responsibilities does each partner have?
- What assets are financed through the public?
- What revenue model is used to recoup investment?
- What requirements must the private partner meet, in terms of service availability, speed, price, build locations, and performance schedules?
- How will the partners determine future buildouts and who pays for them?

PROSPECTIVE PARTNERSHIPS

County of Fresno

The county of Fresno is in the process of developing a fiber master plan that highlights opportunities to work with county stakeholders, including the City of Fresno. Fresno is the largest city in the county, holds the most assets, and has a vision of expanding broadband access and competition, and should take the lead in partnership discussions with the County. The IT department in the City of Fresno has an existing relationship with the County, and the timing of both entities simultaneously undertaking broadband strategic projects offers tremendous potential for coordination and regional approaches. Magellan recommends forming a Joint Powers Authority (JPA) with the County, with an authoritative board that can align major capital projects for cost savings and joint build opportunities, coordinate public policy for broader, more consistent outcomes and impacts, and act as the region's advocate and organizer for broadband access and digital literacy.

Fresno Coalition for Digital Inclusion (FCDI)

FCDI is a non-profit organization that is focused on improving digital inclusion in the County of Fresno and affiliated with other regional organizations with similar goals. The City of Fresno has communities in need of better, more affordable

access to digital technology and education, helping individuals and businesses acquire the knowledge and skills needed to compete and thrive in the digital age, particularly among marginalized socio-economic groups. Alignment and collaboration with FCDI would greatly benefit both groups and open new opportunities for outreach, engagement, and education.

San Joaquin Regional Broadband Consortium (SJVRBC)[9]

SJVRBC has the charge of expanding broadband throughout the San Joaquin Valley. San Joaquin is an adjoining county with the same purposes and goals as the City and County of Fresno, and better communication and coordination can aid both groups in understanding and expanding broadband and digital literacy in the region.

Private Providers

AT&T was interviewed and provided updated information regarding the plans to extend the fiber-to-the-home footprint in Fresno. They also noted their interest in helping with digital literacy projects and offered to work on partnering with the City to close the digital divide. AT&T also showed an interest in doing joint build opportunities with the City when possible. AT&T has a good working relationship with the City of Fresno, and the City should leverage broadband policies and standards that align with AT&T's plans to quickly expand its fiber network while working together on growing ACP participation for affordable access.

CVIN/Vast is a local ISP that has a large fiber network in the City of Fresno and has partnered with the City on many occasions. CVIN/Vast is ready and willing to continue the partnership opportunities in utilizing city assets and sharing resources reach underserved areas of Fresno that have the most immediate needs. This is a partnership that needs to be further explored, particularly since City assets could be leveraged in a public-private partnership arrangement, including potential data centers and operations.

[9] https://www.sanjoaquinvalleynetwork.org/

6. Network Design & Cost

Magellan's team developed a high-level design (HLD) that incorporated the findings from the asset inventory, needs assessment, market assessment, and gap analysis. The HLD is a conceptual network to connect City facilities to a common network while supporting adjoining areas with improved broadband access and competition.

The first step in the design process was to identify the sites and areas that need broadband upgrades. Once the sites, goals, and areas were identified, the existing infrastructure was plotted and assessed to determine how to best utilize it for cost savings and quick deployment. Magellan approached the design assessing the existing environment in order to utilize the most cost-effective construction methods: existing fiber, existing conduit, new aerial, microtrenching, and, if needed, new underground boring.

CONSTRUCTION METHODS

Existing Assets and Infrastructure

Existing assets consist of any conduit, cable, pole, tower, handholes, and rights-of-way that have been previously constructed and have the capacity to be used to add additional or new broadband technologies. Existing infrastructure are the first construction methods considered when starting a design due to the benefits of cost savings and speed to market. It was important to investigate and analyze all possible infrastructure, regardless of which department or company owns the asset.

Existing conduits do not have to be built specifically for fiber, or even be empty; if the conduit has a large enough diameter, a new cable can be pulled in even if there already is a cable installed. Existing fiber cables with very low strand availability can be used effectively with the use of wave division multiplexing and very high bandwidth technologies, reducing the need for high strand count.

Power poles can be used for aerial cable placement and wireless technology deployment. Poles have some inherently attributes that can determine their feasibility for use. The cost for aerial construction is substantially less expensive than other methods, and time to market can be considerably faster. However, some poles may be overloaded and/or unsafe, and thus not suitable to add new cables; poles are also vulnerable to vandalism, weather, and rodent damage. When a pole is overloaded and unsafe for construction, the pole has to be replaced or new underground has to be used to avoid the bad pole, adding to the costs. Due to the physical vulnerabilities, aerial construction is only recommended when the cost savings far outweigh the exposure.

New Construction

New construction is the last option considered when designing a broadband network for two reasons: it incurs a higher cost, yet is slower to deploy due to added permitting, engineering, and construction requirements.

For underground conduit/cable placement, the simplest method is ploughing, which uses a tractor with a blade and conduit or cable is placed as the blade is drug through the ground. However, this method is typically used in greenfield areas without any existing underground infrastructure that might be damaged during the ploughing process.

Microtrenching can be used in places with existing infrastructure; it uses a carbide tipped saw blade that cuts a 24" deep trench through asphalt, dirt, concrete, etc., in which conduit or cable is then placed in the trench and restored back to the original state. However, microtrenching is still an invasive excavation technique that assumes no interconnecting/crossing infrastructure is placed within the 24" area being cut.

Boring can be used to tunnel underneath or between existing underground infrastructure, using a machine that drills rods through the ground at any depth needed and places a conduit in the hole the drilling just created. This is a very expensive method for many reasons, including the high cost of operating and maintaining these machines and the level of engineering required. The liability of underground boring is high because the drilling process is not always precise, and hitting other existing utilities is a real and fairly common possibility.

HIGH LEVEL DESIGN (HLD)

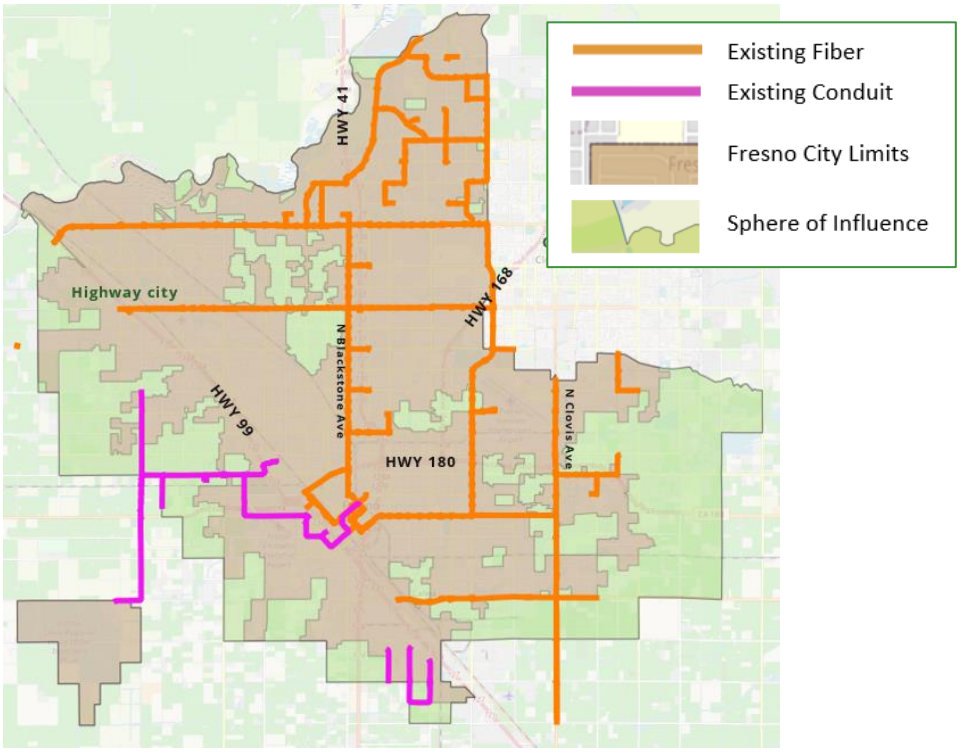
Most HLD's are broken down into phases that allow for logical systematic construction priorities. In order to meet the needs and goals of the City of Fresno, Magellan has developed a unique HLD that is not as formulaic as typical approaches. The conceptual HLD is based on connecting city facilities, parks, and other youth and senior centers that currently have no or inadequate internet access, as well as two pilot areas. The pilot areas have been selected by the City based on the number of households that qualify for the Supplemental Nutrition Assistance Program (SNAP) and/or the federal Affordable Connectivity Program (ACP).

Existing Assets

The existing City-owned/controlled fiber in Figure 15 is depicted in orange and varies in strands availability from 12 to 96 (available strands need to be verified with field engineering); existing conduit is depicted in purple. By leveraging the City's fiber and/or existing conduit through a public private partnership (P3), the City has opportunities to efficiently reach some underserved areas. Existing

conduit can be leased to a private partner (rather than constructed on their own), thereby reducing the capital required, and consequently, improving the return on investment for private companies to build into high-cost areas.

Figure 15. Existing Fiber and Conduit



HLD – Connecting City Facilities

One of the goals of the City was to have the parks and community centers connected to broadband with at least 100 Mbps speeds. There are a couple of options to accomplish this goal. The option shown in Figure 16 proposes the City build laterals off the existing infrastructure and connect the 10 sites identified by the City that are currently without service. An alternative option is to use a public-private partnership where the City's local ISP partner undertakes the service drops/lateral connections and provide the services.

Figure 16. City Construction Needed

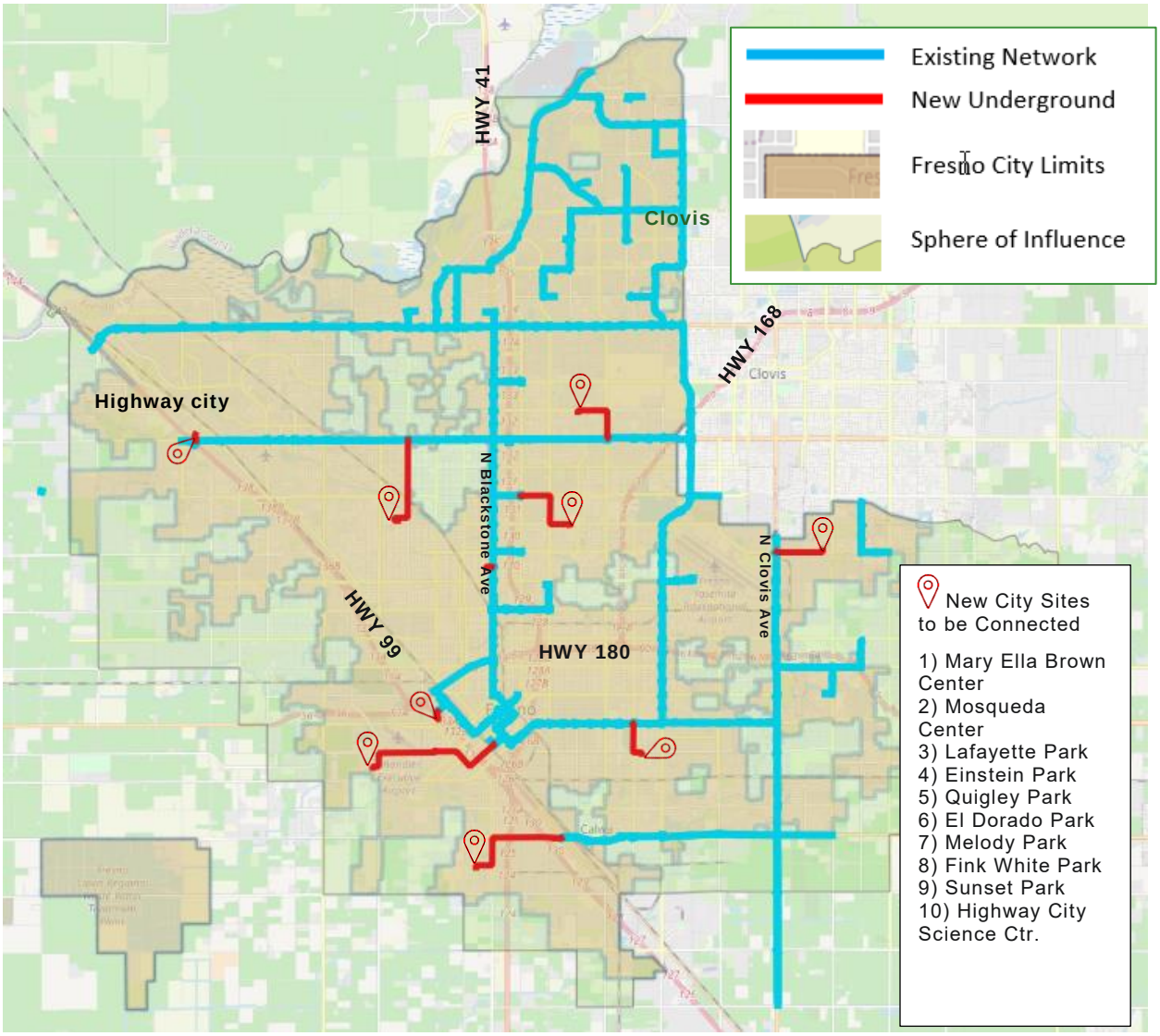


Table 4. New City Sites to Connect with Broadband Services

New City Sites to be Connected	Address
Mary Ella Brown Center	1350 E Annadale Ave.
Mosqueda Center	4670 E Butler Ave.
Lafayette Park	1516 E Princeton Ave
Einstein Park	3566 E Dakota Ave
Quigley Park	808 W Dakota Ave.
El Dorado Park	5161 N. 6th Street
Melody Park	5935 E Shields Ave.
Fink White Park	535 S Trinity
Sunset Park	1345 W Eden Ave.
Highway City Science Ctr.	5140 State Street.

The estimated costs to connect the 10 City facilities is approximately $4.7 million and includes utilizing more than 7,000 feet of existing conduit to reduce the capital required.

Table 5. Estimated Costs to Connect City Facilities

Connect City Facilities Construction Cost

Construction Type	Footage	Per Ft $		Total Estimated Cost
Existing Conduit	7,184.00	25	$	179,600.00
New Underground	50,460.00	90	$	4,541,400.00
Total	**57,644.00**	**90**	**$**	**4,721,000.00**

HLD – Support for Underserved Areas

The City seeks to support underserved areas as defined by the National Technology and Information Administration (NTIA), and Figure 17 identifies a strategy to accomplish this goal. The main reason areas remain underserved is because private companies weigh the capital costs against the market and timeline for a return on their investment; areas that are costly to build but that don't have high projected revenues are often ignored. However, public investment offsets the private capital required, and encourages market entry.

The City can utilize the existing conduit shown in Figure 17 through a public-private partnership with an ISP, thereby lowering the cost of construction to these targeted areas. Notably, these underserved areas can be accessed without any additional construction, but simply by utilizing existing City infrastructure.

Figure 17. Fiber Paths to Reach Underserved Areas

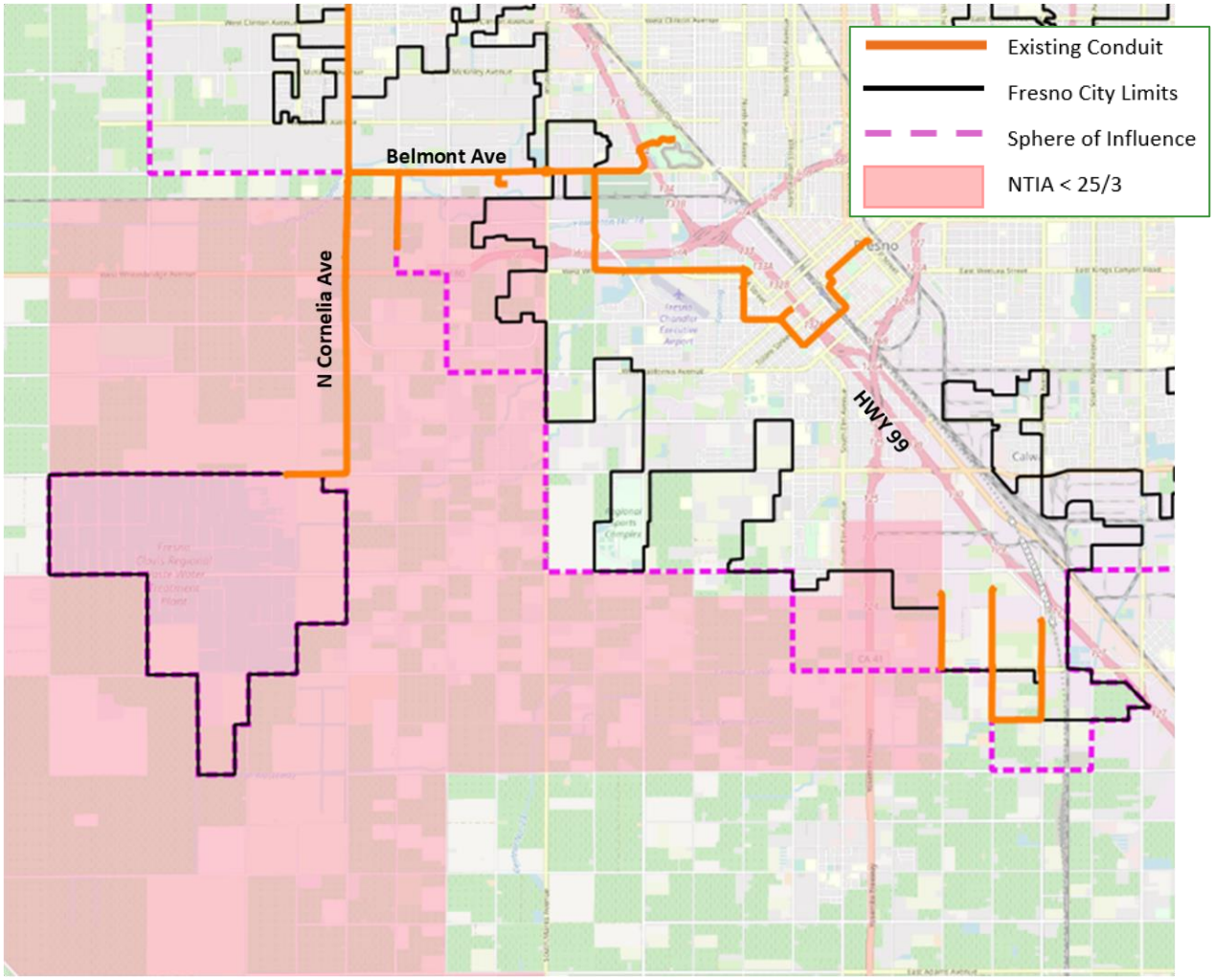


Table 6. Underserved Existing Conduit Totals

Underserved Support Area Estimated Footage

Construction Type	Feet
Existing Conduit	104,524.00
Total	**104,524.00**

HLD – South Central Fresno

The City's South Central Specific Plan (SCSP) contains the following two policies that will be addressed to some degree as part of the Fiber Master Plan and implementation.

- E-11: Increase public access to quality internet service.

- E-12: Prioritize fiber connectivity in the plan area.

More specifically, the Fiber Master Plan has the potential to ease industrial truck traffic through the Plan Area along corridors that utilize traffic signal controls connected by fiber. Additionally, the SCSP policy related to quality internet service will be addressed in the Fiber Master Plan with high-speed broadband through a robust fiber optic network.

Figure 18. South Central Fresno HLD

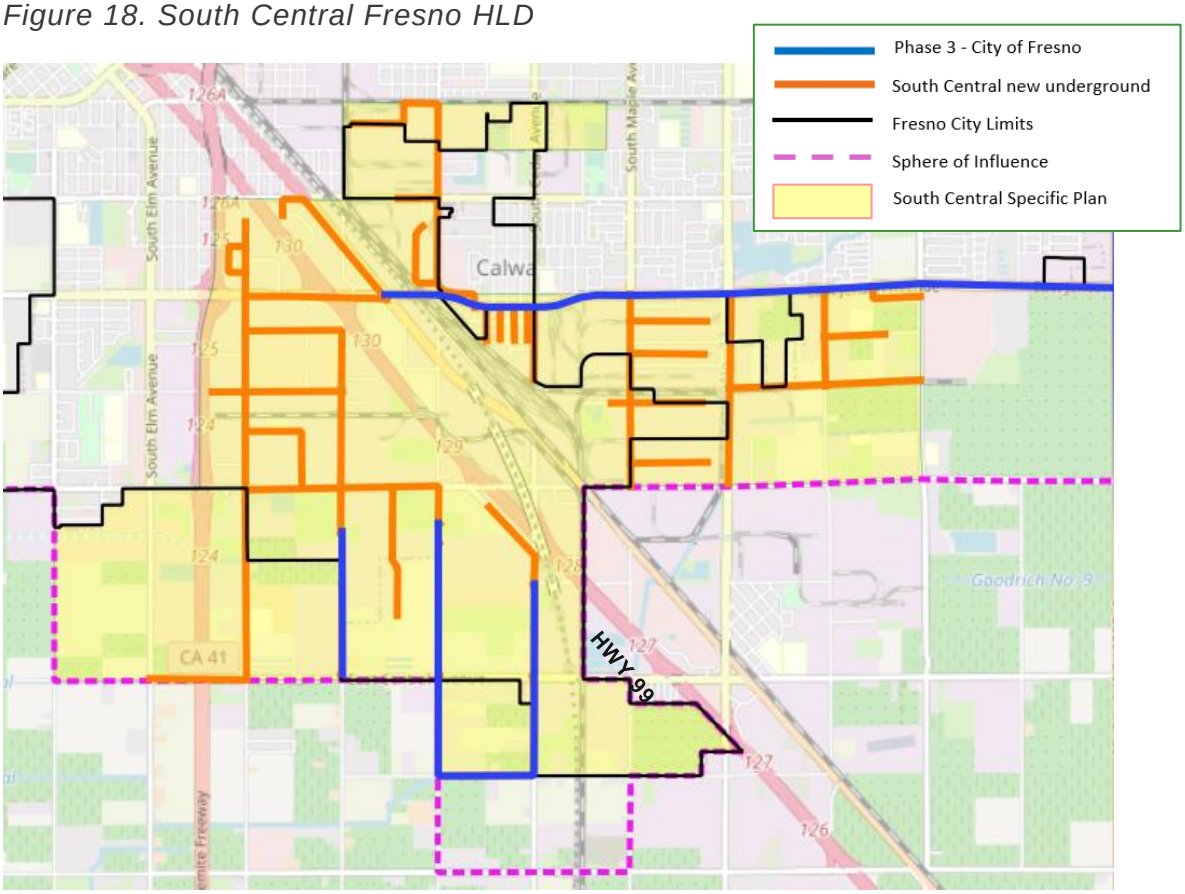


Table 7. South Central Fresno – Fiber Network Estimated Cost

South Central Fresno Estimated Footages and Cost

Construction Type	Footage		Max of Price/Ft		Estimated Total
Existing Conduit	18,766.00	$	25.00	$	469,150.00
New Underground	50,460.00	$	90.00	$	4,541,400.00
Total	**69,226.00**	**$**	**90.00**	**$**	**5,010,550.00**

HLD – PILOT AREAS 1 AND 2

Fresno has economically marginalized areas identified by a higher-than-average household enrollment in the Supplemental Nutrition Assistance Program (SNAP). To help support these areas, the City of Fresno has identified two locations with high density apartments, or multi-dwelling units (MDUs), that have a need for broadband connectivity. MDUs were the focus of these Pilot Areas because constructing fiber to one building can service potentially hundreds of customers and is more cost effective then building to single family homes one at a time. Conceptually, these areas have been designed with a FTTH architecture by supplying fiber connectivity to each detached structure.

Figure 19. Pilot Area 1

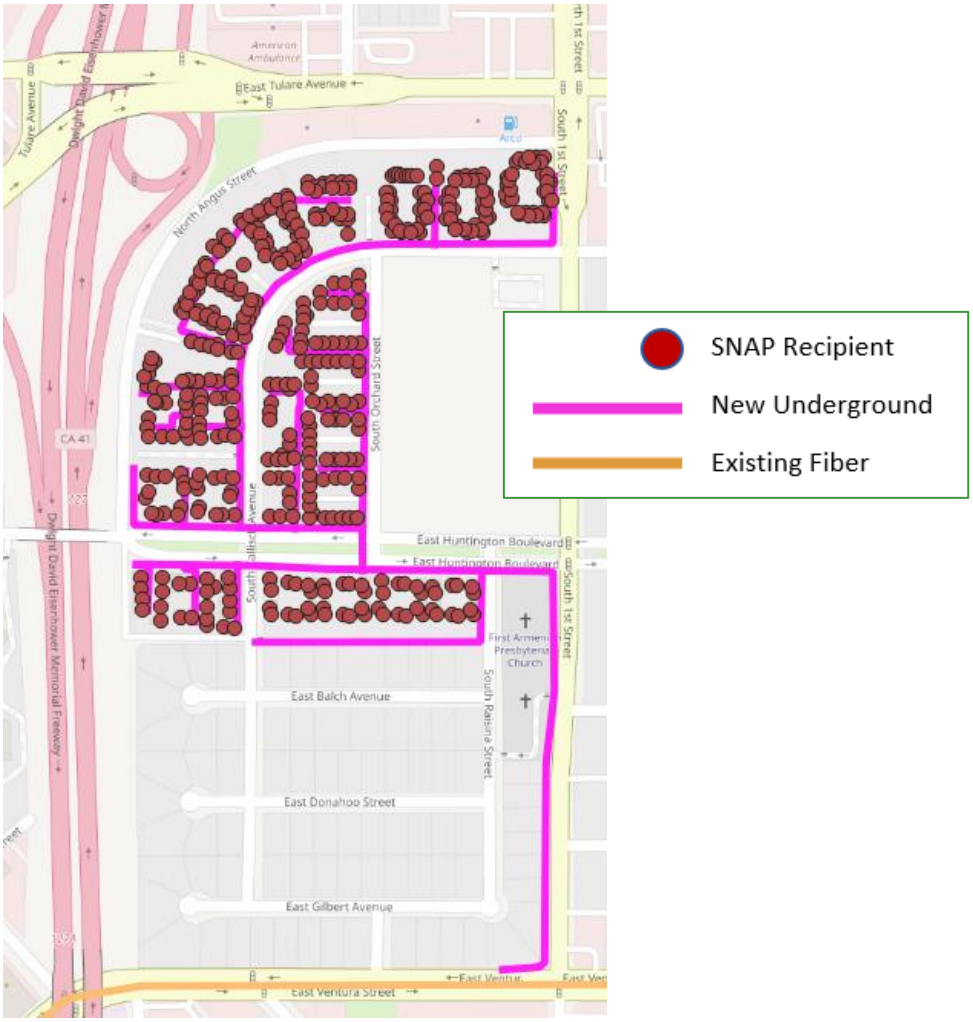


Figure 20. Pilot Area 2

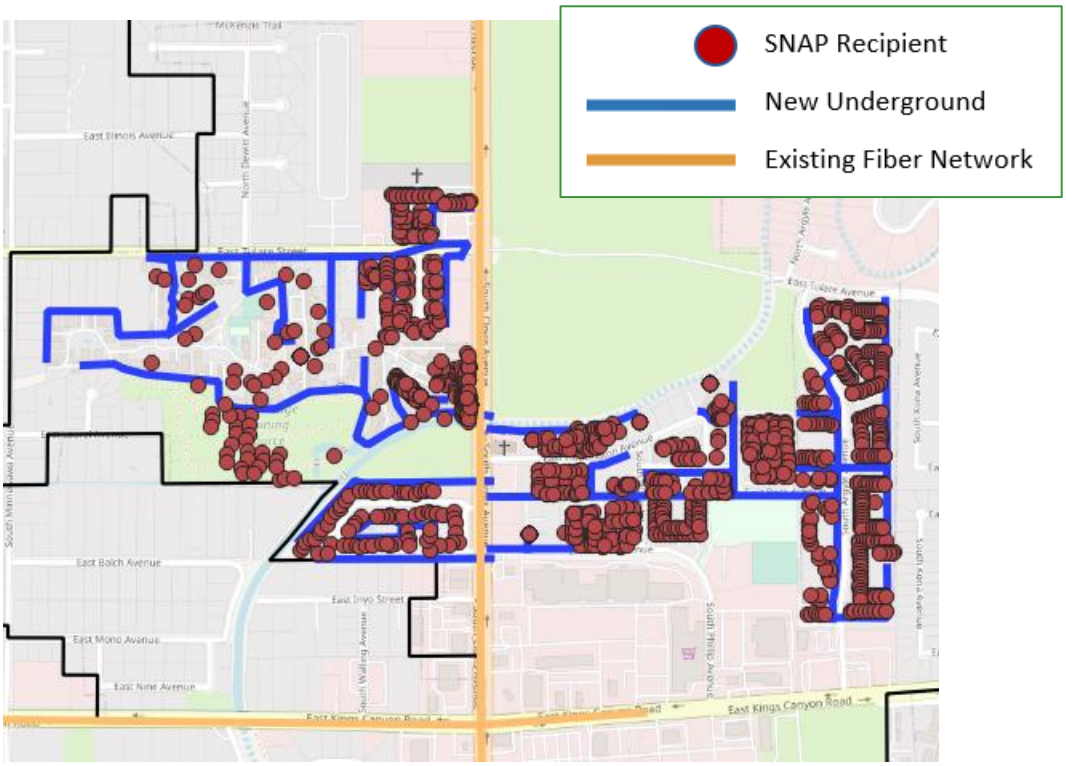


Table 8. Pilot Areas Cost Estimates

Pilot 1 and 2 Estimated Footage and Cost				
Focus Area	**Construction Type**	**Est. FT**	**Max of Price/Ft**	**Sum of Total**
Pilot Area 1 - Path	New Underground	10,636	$ 90.00	$ 957,240.00
Pilot Area 1 - Path Total		**10,636**	**$ 90.00**	**$ 957,240.00**
Pilot Area 2 - Path	New Underground	20,171	$ 90.00	$ 1,815,390.00
	Aerial	5,018	$ 30.00	$ 150,540.00
Pilot Area 2 - Path Total		**25,189**	**$ 90.00**	**$ 2,267,010.00**
Total		**267,219**	**$ 90.00**	**$ 3,224,250.00**

7. Recommendations & Next Steps

Based on Magellan's analysis and research, the following seven recommendations can help the City of Fresno attain its goals of enabling the City to better allocate its information technology resources and to obtain greater benefits for its investments in information technology.

8. **City Broadband Oversight Committee**. Form or designate a committee tasked with broadband advancement and decision-making powers. Create roles and responsibilities, including taking the lead working with local, county, and regional stakeholders for cooperative broadband development and deployment. The committee should research, analyze and advise the City on broadband opportunities and policies, and work to refine workflows and policies that encourage private investment in broadband infrastructure.
9. **Apply & Secure Grant Funding For Phase 1, Pilot Area 1 & Pilot Area 2.** Research and apply for state and federal grants to aid in the planning, design, and construction of fiber assets, particularly grants that target underserved areas and development zones.
    a. **Local Agency Technical Assistance (LATA) –** The City of Fresno was recently awarded the LATA grant in the amount of $496,874 to conduct planning work in preparation for new broadband deployment. The City will utilize the LATA grant funding to complete the full design engineering for Phase 1, Pilot Area 1, and Pilot Area 2.

    b. **SB 156 Last Mile Grant Funding –** Completing the design engineering through the LATA grant will allow the City to submit a competitive grant application for project construction funding through the California Last Mile program, anticipated to be released in late 2022/early 2023. The Last Mile grant program targets un- or under-served areas, such as Pilot Area 1 & Pilot Area 2, as well as the required backbone fiber network to serve those areas.
10. **Connect City 10 City Sites Not Currently Served.** The City identified 10 parks that currently have no broadband service; the High Level Design in Section 6 proposes network expansion to connect these 10 sites into the City's fiber network.
11. **Establish a Data Center**. Offer the space at the historical Bee Building at 1555 Van Ness Ave or the DPU O&M Building complex at 1626 E Street, including through the Golden State Network/Middle-Mile Broadband Initiative, as a data center/colocation building for a Fresno connection point.

12. **City Policies & Standards.** Create workflows and city policies that aid and encourage broadband infrastructure development through dig once policies, updated construction standards, developer agreements and requirements, joint builds on CIP projects, and any other policy needed to further broadband. These policies should be applied to the private and public sectors including any work being performed in the public-right-of-way (PROW). Ensure incremental fiber builds during City-wide projects by creating a mechanism to ensure new builds are fully funded before the incremental build opportunities arise.
13. **Solicit and Nurture Partnerships.** Continue partnership discussions with incumbents and local ISPs, creating a positive environment for unhindered broadband expansion. Solicit new partnerships by leveraging city fiber and conduit infrastructure to connect City facilities, and encourage private expansion into underserved areas, including the South Central Fresno.
14. **Create a Formal Partnership with the County**. Explore formal partnership structures with Fresno County, who is simultaneously undertaking their own broadband strategic planning process, including possibly establishing a Joint Powers Authority (JPA) that can act as a single lead in grant applications and coordination efforts. Interconnecting County facilities within the City of Fresno to existing City facilities will ensure not only significant cost savings, but create a coordinated, robust, and redundant communications network for public safety, emergency operations, and regional planning.

8. Appendix A: Glossary of Terms

3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
5G – Fifth Generation	The fifth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web. It is believed that this technology will significantly increase bandwidth to users, up to 1 Gig.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
ADSS – All-Dieletric Self-Supporting	A type of optical fiber cable that contains no conductive metal elements.
AMR/AMI – Automatic Meter Reading/Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
ATM – Asynchronous Transfer Mode	A data service offering that can be used for interconnection of customer's LAN. ATM provides service from 1 Mbps to 145 Mbps utilizing Cell Relay Packets.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second, kilobits per second (kbps), and Megabits per second (Mbps).

Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPL – Broadband over Powerline	A technology that provides broadband service over existing electrical power lines.
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable Internet).
CAD – Computer Aided Design	The use of computer systems to assist in the creation, modification, analysis, or optimization of a design.
CAI – Community Anchor Institutions	The National Telecommunications and Information Administration defined CAIs in its SBDD program as “Schools, libraries, medical and healthcare providers, public safety entities, community colleges and other institutions of higher education, and other community support organizations and entities.” Universities, colleges, community colleges, K-12 schools, libraries, health care facilities, social service providers, public safety entities, government and municipal offices are all community anchor institutions.

CAP – Competitive Access Provider	(or “Bypass Carrier”) A Company that provides network links between the customer and the Inter-Exchange Carrier or even directly to the Internet Service Provider. CAPs operate private networks independent of Local Exchange Carriers.
Cellular	A mobile communications system that uses a combination of radio transmission and conventional telephone switching to permit telephone communications to and from mobile users within a specified area.
CLEC – Competitive Local Exchange Carrier	Wireline service provider that is authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services in one of three ways or a combination thereof: 1) by building or rebuilding telecommunications facilities of their own, 2) by leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) by leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.
Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel at the demarcation point ("demarc").
CWDM – Coarse Wavelength Division Multiplexing	A technology similar to DWDM only utilizing less wavelengths in a more customer-facing application whereby less bandwidth is required per fiber.
Demarcation Point (“demarc”)	The point at which the public switched telephone network ends and connects with the customer's on-premises wiring.

Dial-Up	A technology that provides customers with access to the Internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the Internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
Downstream	Data flowing from the Internet to a computer (Surfing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver "always on" broadband Internet service.
DSLAM – Digital Subscriber Line Access Multiplier	A piece of technology installed at a telephone company's Central Office (CO) and connects the carrier to the subscriber loop (and ultimately the customer's PC).
DWDM – Dense Wavelength Division Multiplexing	An optical technology used to increase bandwidth over existing fiber-optic networks. DWDM works by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber. In effect, one fiber is transformed into multiple virtual fibers.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Rock Falls, and U.S. territories.

FDH – Fiber Distribution Hub	A connection and distribution point for optical fiber cables.
FTTN – Fiber to the Neighborhood	A hybrid network architecture involving optical fiber from the carrier network, terminating in a neighborhood cabinet which converts the signal from optical to electrical.
FTTP – Fiber to the premise (or FTTB – Fiber to the building)	A fiber-optic system that connects directly from the carrier network to the user premises.
FTTx – Fiber to the X	All fiber optic topologies from a provider to its customers, based on the location of the fiber's termination point
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
GSM – Global System for Mobile Communications	This is the current radio/telephone standard developed in Europe and implemented globally except in Japan and South Korea.
HD – High Definition (Video)	Video of substantially higher resolution than standard definition.
HFC – Hybrid Fiber Coaxial	An outside plant distribution cabling concept employing both fiber-optic and coaxial cable.

ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), but it is more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
IEEE – Institute of Electrical Engineers	A professional association headquartered in New York City that is dedicated to advancing technological innovation and excellence.
ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
IP-VPN – Internet Protocol-Virtual Private Network	A software-defined network offering the appearance, functionality, and usefulness of a dedicated private network.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – Internet Service Provider	A company providing Internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
ITS – Intelligent Traffic System	Advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.

LAN – Local Area Network	A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless Internet connection.
LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long distance service. Calls within a LATA (IntraLATA) typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
Middle Mile Network	Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area where it interconnects with major carriers.
MPLS – Multiprotocol Label Switching	A mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.

ONT – Optical Network Terminal	Used to terminate the fiber-optic line, demultiplex the signal into its component parts (voice telephone, television, and Internet), and provide power to customer telephones.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared among many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a government service or private business venture that is funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P^3.

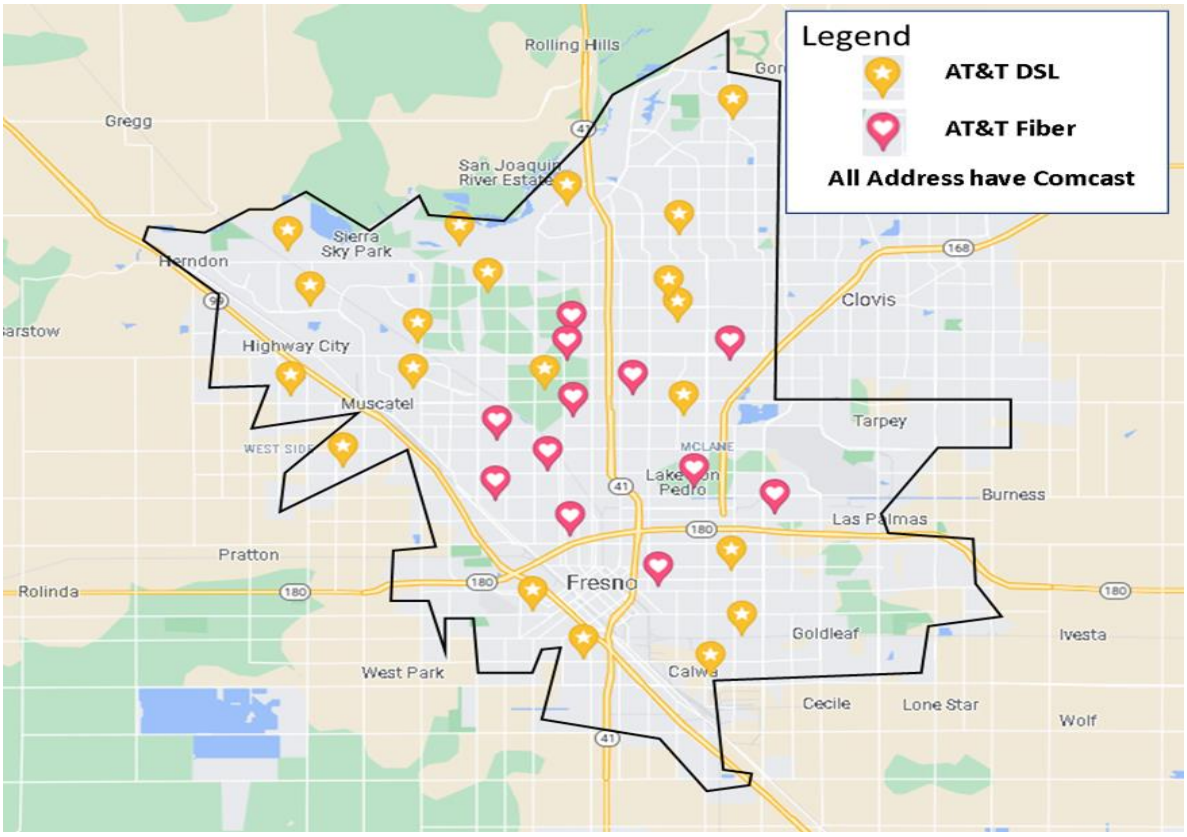
QOS – Quality of Service	QoS (Quality of Service) refers to a broad collection of networking technologies and techniques. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results, which are reflected in Service Level Agreements or SLAs. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic.
RF – Radio Frequency	a rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennas.
RMS – Resource Management System	A system used to track telecommunications assets.
RPR – Resilient Packet Ring	Also known as IEEE 802.17, is a protocol standard designed for the optimized transport of data traffic over optical fiber ring networks.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as “REA” or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world.
SNMP – Simple Network Management Protocol	An Internet-standard protocol for managing devices on IP networks.

SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Streaming	Streamed data is any information/data delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Submarine Network	Submarine networking is the process by which data is carried on subsea cables to connect continents. Submarine networks carry 95 percent of the world's intercontinental electronic communications traffic.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.
T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.
Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flowing from your computer to the Internet (sending E-mail, uploading a file).

UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission.
VDSL – Very High Data Rate Digital Subscriber Line	A developing digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires (up to 52 Mbit/s downstream and 16 Mbit/s upstream), and on coaxial cable (up to 85 Mbit/s down and upstream); using the frequency band from 25 kHz to 12 MHz.
Video on Demand	A service that allows users to remotely choose a movie from a digital library whenever they like and be able to pause, fast-forward, and rewind their selection.
VLAN – Virtual Local Area Network	In computer networking, a single layer-2 network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network, Virtual LAN or VLAN.
VoIP – Voice over Internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using Internet Protocol.
VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of dedicated connections, encryption, or a combination of the two.

WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
WiFi	WiFi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The WiFi Alliance defines WiFi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards".
WiMAX	WiMAX is a wireless technology that provides high-throughput broadband connections over long distances. WiMAX can be used for a number of applications, including “last mile” broadband connections, hotspot and cellular backhaul, and high speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless Internet	1) Internet applications and access using mobile devices such as cell phones and palm devices. 2) Broadband Internet service provided via wireless connection, such as satellite or tower transmitters.
Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.

9. Appendix B: Service Addresses Tested



ADDRESS	PROVIDER TECHNOLOGY	PROVIDER
3247 E MONO AVE, FRESNO, CA 93702	AT&T Fiber	Comcast
4009 ARDEN DR S, FRESNO, CA 93703	AT&T Fiber	Comcast
1007 E FAIRMONT AVE, FRESNO, CA 93704	AT&T Fiber	Comcast
288 W SAN RAMON AVE,	AT&T Fiber	Comcast

FRESNO, CA 93704		
1133 E PONTIAC WAY, FRESNO, CA 93704	AT&T Fiber	Comcast
566 E TERRACE AVE, FRESNO, CA 93704	AT&T Fiber	Comcast
732 W CORTLAND AVE, FRESNO, CA 93705	AT&T Fiber	Comcast
2815 E SWIFT AVE, FRESNO, CA 93726	AT&T Fiber	Comcast
4567 E FAIRMONT AVE, FRESNO, CA 93726	AT&T Fiber	Comcast
4881 E FLORADORA AVE, FRESNO, CA 93727	AT&T Fiber	Comcast
1544 N PACIFIC AVE, FRESNO, CA 93728	AT&T Fiber	Comcast
1122 E BREMER AVE, FRESNO, CA 93728	AT&T Fiber	Comcast
2084 E BRANDYWINE LN, FRESNO, CA 93720	AT&T DSL	Comcast
7540 N 8TH ST, FRESNO, CA 93720	AT&T DSL	Comcast
346 W LEXINGTON	AT&T DSL	Comcast

AVE, FRESNO, CA 93711		
7270 N SEQUOIA AVE, FRESNO, CA 93711	AT&T DSL	Comcast
5234 W SPRUCE AVE, FRESNO, CA 93722	AT&T DSL	Comcast
1672 W VARTIKIAN AVE, FRESNO, CA 93711	AT&T DSL	Comcast
4753 W MESA AVE, FRESNO, CA 93722	AT&T DSL	Comcast
5232 N LEAD AVE, FRESNO, CA 93711	AT&T DSL	Comcast
4165 N CONSTANCE AVE, FRESNO, CA 93722	AT&T DSL	Comcast
3114 W HOLLAND AVE, FRESNO, CA 93722	AT&T DSL	Comcast
4306 W HARVARD AVE, FRESNO, CA 93722	AT&T DSL	Comcast
1266 E MESA AVE, FRESNO, CA 93710	AT&T DSL	Comcast
529 E HOLLAND AVE, FRESNO, CA 93704	AT&T DSL	Comcast
5556 N 6TH ST, FRESNO, CA 93710	AT&T DSL	Comcast

3786 E PONTIAC WAY, FRESNO, CA 93726	AT&T DSL	Comcast
227 E OLEANDER AVE, FRESNO, CA 93706	AT&T DSL	Comcast
2370 S IVY AVE, FRESNO, CA 93706	AT&T DSL	Comcast
155 S MERIDIAN AVE, FRESNO, CA 93702	AT&T DSL	Comcast
2525 S PAGE AVE, FRESNO, CA 93725	AT&T DSL	Comcast
4648 E WOODWARD AVE, FRESNO, CA 93702	AT&T DSL	Comcast

10. Appendix C: Case Studies

Public Policy Case Study: Santa Cruz County, California

In 2013, the Santa Cruz County Board of Supervisors approved an overhaul of its broadband infrastructure plans and regulations. Specific areas of focus included permitting fee reductions and joint-build opportunities.

The initiatives were crafted into a comprehensive set of policies that addressed:

- A "dig once" process that requires notification and an opportunity for broadband companies to joint build or add infrastructure whenever excavation takes place, making it easier to install fiber-optic cables during other scheduled work on roads or utilities lanes.
- Development of master lease agreements to simplify access to county facilities.
- Including fiber-optic conduit requirements as part of all public works projects, new developments, and land divisions.

Public Services Provider Case Study: Seminole County, Florida

Seminole County owns and operates a 450-mile fiber-optic network that was installed over the past 20 years primarily to serve transportation needs. The County's Traffic Engineering Group initially developed the network by connecting traffic signals to fiber in the early 1990s to provide enhanced communications and better reliability. What was originally conceived to be a transportation upgrade ultimately became a telecommunications resource that now connects public organizations across the County.

To date, the network connects 26 fire stations, 58 county buildings, 44 schools, 4 Seminole State College campuses, 41 city buildings, and 17 water treatment plants. In addition, the department maintains over 375 traffic signals, 148 school flashers at 73 locations, 46 beacons and flashers, and 29 variable message signs. The fiber network consists of different types of cables and strand counts: single mode, multi-mode, and hybrid, resulting in approximately 1,246 active strand pair miles of fiber.

Seminole County's network has saved its public service organizations millions of dollars and has enabled the county and its cities to:

- Share resources between the county, cities, schools and community colleges
- Aggregate demand for public procurements to attain volume purchasing power
- Provide inter-jurisdictional public safety communications between the county and cities

- Reduce public organizations spend on communications services
- Future-proof the communications needs of all organizations connected to the network

Infrastructure Provider Case Study: Santa Monica, California

In 2002, when Santa Monica renewed its franchise with the local cable provider, it also included a lease of fiber-optic network capacity to connect various schools and community college sites. The city paid construction costs of $530,000 and shared the ongoing costs with the schools and community colleges but were then able to switch off of circuits leased from private telecom companies, saving a combined $400,000 in annual telecommunications costs. The savings was used as seed capital for the development of the city's own fiber-optic network.

Today, 126 businesses are connected to Santa Monica's CityNet. The network covers approximately eight square miles and soon will be delivering up to 100 Gbps of symmetrical broadband access. Prices for services are negotiated for each business customer individually. CityNet was able to achieve the following goals for the community:

- Lower costs of Internet access for the city and schools
- Establish free Wi-Fi in 35 public hot zones as well as distribute 375 computers in kiosks and libraries in town for free access
- Nurture existing businesses, attract new businesses, support startups, VCs, and incubators
- Create an environment for other incumbents to invest in city infrastructure

Open Access Provider Case Study: Palm Coast, Florida

In 2006, the Palm Coast City Council approved a 5-Year, $2.5 million fiber-optic deployment project. The network was developed to support growing municipal technology needs across all public organizations, including city, county, public safety, and education. The city utilized a phased approach to build its network using joint build and dig once opportunities, and aligning installation with other CIP projects. As each phase was constructed, the City connected its own facilities as well as coordinated connections to other public organizations. Through deployment of this network since 2007, the City has realized a savings of nearly $2 million, while simultaneously generating over $500,000 annually in new revenue from other network users.

In a market where local fiber was scarce and unaffordable for all but the largest businesses, Palm Coast FiberNet now provides fiber access to the local area. Service providers utilize the network to deliver Internet and business communications services for significantly lower costs than were previously

available. The city has enabled new competition and introduced a competitively priced fiber product into the wholesale market.

Municipal Business Retail Provider Case Study: Hudson, Ohio

Similar to other communities that have recently decided to invest in municipal networks, Hudson's focus is solely on Internet and Voice Over Internet Protocol (VOIP). The gigabit network will be deployed incrementally by Hudson Public Power focusing on downtown and areas of high demand. Through the reinvestment of service fees from customers, the city plans to grow the network as a self-sustaining venture.

Hudson's municipal network is marketed under the name Velocity Broadband and is one of the first cities in the Midwest to offer gigabit connectivity.

Municipal Residential Retail Provider Case Study: Morristown, Tennessee

At the time of Morristown's initial deployment in 2004, fiber-to-the-home was not a common practice. However, once the City realized that fiber was a way to secure the network investment for the future, it was an easy decision. Nearly a decade later, the future-proofed network was able to quickly and easily upgrade to gigabit speeds without touching the fiber but by simply replacing the electronics.

Morristown Utility System (MUS) FiberNet started signing up customers in 2006, and by 2008 had a take rate of 33%, with take rates in 2015 over 44% of homes passed, and a greater percentage of businesses. Out of the four service providers that Morristown has for broadband, 80% of residents have availability to choose from at least two of those providers[10] and 100% of Morristown households have access to broadband Internet.

FiberNet's have had numerous positive impacts, including:

- Cash flow positive two years after launch, net income positive after five years
- Revenues of $8.6 and $8.9 million in 2013 and 2014, respectively
- Businesses and residents saving $3.4 million annually
- $840,000 in savings from a smart meter program
- Attracting major employers and private investment that have added hundreds of jobs and brought in 21st Century industries, including biotech firms

[10] http://www.musfiber.net

Public Private Partnerships Case Study: Ontario and Rancho Cucamonga, California

The cities of Ontario and Rancho Cucamonga in California both contracted with Inyo Networks DBA: Onward in P3 agreements, where Onward functions as the network operator and retail provider of business and residential fiber service, but the cities remain owner of the asset. The cities receive a percentage of gross revenues generated from the network assets, and in turn are responsible for all capital cost associated with fiber expansion.

Onward provides a full suite of IP enabled services, including cable TV, phone (VOIP) and symmetrical gigabit Internet services. Retail 1 Gbps residential service starts at $69 per month, and a 1 Gbps business service at $250 per month.