

# MEMORANDUM

**TO:** UTILITIES ADVISORY COMMISSION  
**FROM:** UTILITIES DEPARTMENT  
**DATE:** February 7, 2018  
**SUBJECT:** Fiber Utility Update

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This fiber utility update provides a summary of highlights of the City's dark fiber optic backbone network, including the current status of various initiatives to expand the network for citywide fiber-to-the-premises and wireless services. This update has been prepared to keep the UAC apprised of the major efforts and issues associated with the fiber utility.

Staff is requesting UAC feedback regarding current efforts related to the fiber-to-the-node/fiber-to-the premises request for proposal (RFP) to retain a management consultant to prepare a business case, in addition to strategic advice regarding the City's future broadband expansion opportunities. The overall objective is to fully leverage the existing fiber network and reserves to support new and future applications and technologies dependent on gigabit-speed broadband, in addition to identifying potential public-private partnership opportunities. Staff is also seeking UAC feedback on the most effective structure for reporting progress and advising the City Council on the work ahead.

Attachment A: Fiber Overview and Initiatives

**PREPARED BY:** JIM FLEMING, Senior Management Analyst   
**REVIEWED BY:** DAVE YUAN, Strategic Business Manager   
**APPROVED BY:**   
ED SHIKADA  
Utilities General Manager

## OVERVIEW OF CITY DARK FIBER OPTIC BACKBONE NETWORK

### FIBER-TO-THE-PREMISES AND WIRELESS COMMUNICATIONS INITIATIVES

#### Executive Summary

This document is intended to provide a summary of the highlights of the City's dark fiber optic backbone network, in addition to various initiatives to expand the network for citywide fiber-to-the-premises and wireless services. It is only meant to inform the reader who wants to understand the history of the City's dark fiber network and recent broadband initiatives.

#### City of Palo Alto Dark Fiber Optic Backbone Network

The dark fiber optic backbone network ("fiber network") was originally conceived by the City in the mid-1990s and is maintained and operated by City of Palo Alto Utilities ("CPAU"). The City's initial telecommunications strategy was to build a dark fiber ring around Palo Alto that would be "capable of supporting multiple network developers and/or service providers with significant growth potential." In the mid-1990s, most investor-owned and public utilities invested in fiber optics to improve command and control of their utility infrastructure. Many of these networks typically had excess capacity that could be licensed or leased to third parties.

The first phase of the fiber backbone construction occurred in 1996-1997. The initial portions of the network were constructed in a backbone ring architecture in existing utility rights-of-way. The fiber backbone was routed to pass and provide access to key City facilities and offices. The majority of the City's business parks (e.g. Stanford Research Park) and commercial properties are also passed by the fiber backbone. The original fiber backbone consisted of 33 route miles with 144 or more strands of single-mode fiber along most routes. Since the late 1990s, the fiber backbone has been expanded to approximately 49 route miles of mostly 144- or 288-count single-mode fiber.

Fiber network construction was financed internally by the Electric Enterprise Fund through a 20-year, \$2 million loan at a 0% interest rate. These funds were used to construct the network and to cover operating expenses. At the end of Fiscal Year 2008, the fiber optics business completed the loan repayment to the Electric Enterprise Fund for all capital and operating expenses from the beginning of the project. A separate Fiber Optics Enterprise Fund, capable of maintaining its own capital and operating budgets and financial operating reserve, was also created. In Fiscal Year 2009, a Fiber Optics Enterprise Fund Rate Stabilization Reserve (RSR) was established.

The fiber network was built in part in response to telecommunications service providers such as emerging Competitive Local Exchange Carriers (CLECs) that would use available dark fiber to provide various telecom services. In the mid-1990s, there was a high demand for fiber transport facilities to support the expansion of bandwidth-intensive broadband services.

By the late 1990s, many CLECs left the market either through mergers with other CLECs or bankruptcy; the so-called "dot com bust" also occurred at roughly the same time. As a result, the anticipated demand for dark fiber in the original target market proved to be somewhat limited. By the late 1990s there was a glut of available dark fiber in many areas of the country. Nonetheless, it was evident that a fiber network would be a valuable asset for command and control of City of Palo Alto Utilities (CPAU) facilities (e.g. electric substations) and other critical City infrastructure such as the traffic signal system. The network would also support a wide range of broadband voice, data and video applications for City

departments, in addition to various commercial users, telecommunications service providers, and the community as a whole.

In 2000, the City began to license “dark fiber” for commercial purposes. Dark fiber is unused fiber through which no light is transmitted, or installed fiber optic cable not carrying a signal. The basic business model is to provide dark fiber connectivity to users requiring access to large amounts of bandwidth. Customers are responsible for providing and maintaining the equipment to “light-up” or provision licensed fiber strands. Dark fiber is licensed or leased by a provider such as the City without the accompanying transmission service. In contrast, traditional telecommunication service providers only make available certain products (commonly known as “managed services”) within their service options that may not adequately meet the requirements of the specific applications.

The fiber network has high market share and brand awareness among commercial enterprises and other organizations that need the quantity and quality of bandwidth provided by direct fiber optic connections.

By connecting to the City’s fiber backbone, the customer gains fiber access to their Internet Service Provider (ISP) of choice. A dark fiber customer can interconnect communications systems or computer networks across multiple Palo Alto locations and can also connect directly to their local and/or long distance carrier(s) of choice with a full range of communications services. Dark fiber customers can also have redundant telecommunication connections for enhanced reliability.

Many of the City’s commercial dark fiber customers gain access to the Internet through the Palo Alto Internet Exchange (PAIX, now owned by Equinix). PAIX is a carrier-neutral collocation facility and hosts over 70 ISPs at their facility located in downtown Palo Alto. Equinix has similar facilities in the Americas, Europe, Middle East and Asia.

The City currently licenses dark fiber connections to 108 commercial customers. The fiber network also serves the following City accounts: IT Infrastructure Services, Utilities Substations, Utilities Engineering, Public Works, Water Quality Control Plant and Community Services (Art Center). The total number of dark fiber service connections serving commercial customers and the City is 221 (some customers have more than one connection). At the end of fiscal year 2017, the licensing of dark fiber service connections resulted in a fiber reserve of approximately \$28 million. According to the proposed Fiscal Year 2018 Budget, the fiber reserve is projected to increase by \$1.1 million.

Annual dark fiber license revenues come from the following customer categories:

- City service connections: 27% of gross revenues.

Private sector entities licensing dark fiber from the City:

- Resellers: 42% of gross revenues. “Resellers” are telecommunication companies that purchase large amounts of transmission capacity from other carriers and resell it to smaller end-users. Examples of resellers are telecom companies that sell broadband, telephony and video services to the commercial and residential markets.
- Various commercial enterprises: 31% of gross revenues. Examples of private end-users are companies involved in various technologies, web hosting, social media, finance, medical, pharmaceuticals, research and development, software, law firms, consulting firms, e-commerce, etc.

- Service offerings: Dark fiber backbone license fees are based on the number of fiber miles per month. Utility Rate Schedule EDF-3 (Dark Fiber Licensing Services) base license price is between \$213 to \$425 per fiber mile, per month. Typical installation costs range from \$500 for a building with existing fiber to \$8,000 or more for installations requiring extensive substructure. Available configurations include point-to-point and diverse rings. For more information regarding commercial dark fiber services, refer to the City's website: <https://www.cityofpaloalto.org/gov/depts/utl/business/programs/fibernet.asp>

The majority of business parks and commercial properties are passed by the fiber backbone. In 2014, CPAU completed a project to serve 18 Palo Alto Unified School District facilities with dark fiber service connections (17 schools and the District's Business Office).

### **Fiber Optic Network Rebuild Capital Improvement Project (FO-16000)**

In 2016, CPAU retained Celerity Integrated Services, Inc. to provide a one-time comprehensive review and audit of the City dark fiber optic network. Celerity completed the review and audit and provided a physical description of the network; documented the number of fiber strands, in addition to conducting an inspection of 90 fiber nodes/cabinets (i.e. network splice points) to identify what is labeled within the individual nodes/cabinets.

The rebuild project will install new aerial duct or substructure (conduit and boxes), in addition to fiber backbone cable to increase capacity for sections of the dark fiber ring that are at or near capacity. This project will allow CPAU to meet customer requests for services. The project areas primarily cover the Stanford Research Park, Palo Alto Internet Exchange/Equinix at 529 Bryant, and Downtown areas. This project basically "overlays" new fiber over existing fiber routes in the network. Existing fiber will continue to serve City facilities and commercial dark fiber customers.

#### **Rebuild Work Completed**

The route from PAIX at 529 Bryant to the Park Boulevard Substation has been completed. This phase of the project included substructure work, fiber pulling and cabinet installation. The new fiber installed for the backbone rebuild is 312-count single-mode fiber (2 x 144-count single-mode fiber, plus 24-count single-mode fiber).

Upcoming work scheduled over the next 12 months:

- Route from Park Substation to Hansen Substation
- Route from Hansen Substation to Stanford Research Park
- Additional phases/routes to be determined.

The estimated cost for the rebuild is between \$500,000 and up to \$1,000,000 for substructure work. Another \$250,000 for the overhead portion of the work is allocated for the project. CPAU crews are performing the equipment installation, cable pulling and terminations. CPAU's substructure contractor is installing the conduit and boxes.

#### **Other Capital Improvement Projects (CIP)**

In 2018, the City will complete installation of fiber optics for Public Works' pump stations and creek monitoring at 17 locations.

For the Downtown Upgrade CIP (water and gas pipes), fiber optic conduits will be installed to support the Council's directive for a "Dig Once" strategy to increase the availability of fiber infrastructure in the downtown area.

## Fiber-to-the-Premises

For more than fifteen years, the City has worked to develop a business case to build a citywide Fiber-to-the-Premises (“FTTP”) network to serve homes and business. A number of business models have been evaluated. The following is a summary of the highlights to develop a network:

**1999:** A Request for Proposal (RFP) was issued to build citywide FTTP. There were no viable bids.

**2000-2005:** In 2000, the City Council approved a Fiber-to-the-Home (“FTTH”) trial to determine the feasibility of providing citywide FTTH access in Palo Alto. The FTTH trial passed 230 homes and included 66 participants in the Community Center neighborhood. The purpose of the trial was to test the concept of fiber-to-the-home. The FTTH trial proved successful (i.e., proved technical feasibility), but when initial investment and overhead expenditures were included in the calculation to create a business case, it was not profitable for the City and the trial was ended in December 2005.

- **Title: UAC Recommendation regarding Fiber to the Home Financing Options**  
<https://www.cityofpaloalto.org/civicax/filebank/documents/5292>
- **Title: Recommendation to Terminate Fiber to the Home Trial and Discontinue Monitoring of Financing Methods in Other California Jurisdictions**  
<https://www.cityofpaloalto.org/civicax/filebank/documents/5684>

**2006-2009:** In 2006, the City issued another RFP and negotiated with a consortium of private firms to build FTTP under a public-private partnership model. In 2009, Staff recommended to Council termination of the RFP process and negotiations due to the lack of financial resources of the private firms.

**2010:** The City responded to Google Fiber’s Request for Information.

**2011:** Staff worked with two telecommunications consulting firm to evaluate the expansion of the existing dark fiber network for its commercial dark fiber licensing enterprise and also to expand the network on an incremental basis to attract a “last mile” FTTP builder and operator. This is a link to the staff report provided to the Utilities Advisory Commission in June of 2011, and the Council Finance Committee in November of 2011:

- **Title: Provide Feedback on the Development of a Business Plan for the Citywide Ultra-High-Speed Broadband System Project**  
<http://www.cityofpaloalto.org/civicax/filebank/documents/27421>

**2012:** Staff worked with a telecommunications consulting firm to study the feasibility of an alternative model for citywide FTTP which would rely on homeowners paying on a voluntary basis for some or all of the cost to build-out the existing dark fiber network into residential neighborhoods. The name of this model is “user-financed” FTTP. The analysis concluded that an opt-in FTTP network can be built using a combination of upfront user fees and City financing; however, there is very little probability of the debt incurred being repaid through operations. Ongoing subsidies would be required, very likely in excess of surpluses in the Fiber Optics Fund reserve generated by licensing dark fiber. The

study was supported by a market survey which concluded there was limited interest among residents in this model. This is a link to the staff report provided to the Utilities Advisory Commission in June 2012:

- **Title: Request for Feedback Concerning the Dark Fiber Optic Backbone Network**  
<http://www.cityofpaloalto.org/civicax/filebank/documents/30112>

**2013 - 2015:** The City Council started its “*Technology and the Connected City*” initiative and directed staff to prepare a *Fiber-to-the-Premises Master Plan* and a *Wireless Network Plan*. In 2014, a Citizen Advisory Committee was appointed by the City Manager. The Citizen Advisory Committee is structured in a way for individual citizens to share opinions and perspectives, study issues, and develop recommendations. In 2015, staff worked with a telecommunications consulting firm, CTC Technology & Energy, to prepare these plans and they were provided in this September 28, 2015 Council staff report:

- **Title: Discussion of Fiber-to-the-Premises and Direction on Next Steps for Fiber and City Wireless Services**  
<http://www.cityofpaloalto.org/civicax/filebank/documents/49073>

At the September 28, 2015 Council meeting, staff and the consultant reviewed these plans with the Council Members. As a result, a Council Motion directed staff to pursue several initiatives, which are described in this August 16, 2016 staff report which updated the Council about the various activities from the Motion:

- **Title: Fiber-to-the-Premises update on City Council Motions and Google Fiber**  
<http://www.cityofpaloalto.org/civicax/filebank/documents/53363>

**2014 - 2016:** Google Fiber announced Palo Alto as a potential “Google Fiber City” for a build-out of their fiber optic network. Since early 2014, staff worked with Google personnel to complete an extensive checklist process regarding City infrastructure and processes, in addition to negotiating agreements for a project description, utility pole attachments, encroachment permits, environmental reviews and other agreements for cost recovery for use of staff time. Based on Council direction, staff also worked with Google to develop a “co-build” concept to explore the feasibility of building a City network in parallel with Google’s network. In July 2016, Google announced a delay in their plans for up to six (6) months to build a fiber optic network in Silicon Valley, which also included Mountain View, San Jose, Santa Clara and Sunnyvale. Google advised staff that they are exploring more innovative ways to deploy their network, which may include implementing wireless technologies. Co-build discussions were also delayed. At this time, there is no activity related to Google Fiber.

In the summer of 2016, the City approved permits for two cabinets so AT&T can begin to deploy their “AT&T Fiber” service. AT&T is exploring deployment of additional cabinets in 2017-18.

On December 12, 2016, staff provided Council with an informational update regarding Fiber-to-the-Premises and wireless initiatives:

- **Title: Update for Fiber-to-the-Premises and Wireless Initiatives**  
<http://www.cityofpaloalto.org/civicax/filebank/documents/55016>

**2017**

**April 5, 2017:** Staff provided the UAC with three options for the City's fiber utility:

1. Future Plans for Fiber and Broadband Expansion;
  - OPTION 1: Municipally-Owned Fiber-to-the-Premises (FTTP);
  - OPTION 2: Municipally-Owned Fiber-to-the-Node (FTTN) Network with Neighborhood/Private Last Mile Provision;
  - OPTION 3: Pause Municipal FTTP Development Efforts; Increase Transparency and Predictability for Third Party Providers.
2. Expand Wi-Fi to Unserved City Facilities; and Discontinue Consideration of City-Provided Wi-Fi in Commercial Areas  
<https://www.cityofpaloalto.org/civicax/filebank/documents/56779>

The UAC made a motion to recommend Council approval of Option 2, taking into account UAC feedback on that option including the idea of a neighborhood beta where the City would build to the node and extend fiber and/or wireless to one neighborhood to gather data, experiment new applications, and explore partnerships. The UAC also approved the recommendations on wireless expansion, excluding extension of Wi-Fi to the golf course and discontinue consideration of City Wi-Fi in commercial areas.

**May 23, 2017:** Staff provided the Council Policy and Services Committee with a report recommending Option 2 for the Municipal Fiber-to-the-Node Network (FTTN) for Fiber and Broadband Expansion; and (2) Expand Wi-Fi to Unserved City Facilities and Discontinue Consideration of City-Provided Wi-Fi in Commercial Areas

- **Title: *Expansion Plan for Fiber Optic Network and Wireless Network (ID # 7735)***  
<https://www.cityofpaloalto.org/civicax/filebank/documents/57822>

The Policy and Services Committee approved the wireless recommendations and elected Option 2 (FTTN). Staff was also directed to:

- Define more clearly the goals of Fiber-to-the-Node (FTTN);
- Reach out to other communities on approaches post Google and share strategies and funding models;
- Include ROI estimates;
- Present a rollout strategy w with an estimate of how many homes will be passed; and
- Draft a communication strategy.

**August 21, 2017:** Staff provided the Council with a report for a work plan for Fiber-to-the-Premises and Wireless Network. Staff, UAC and the Policy and Services Committee recommended Council to:

1. Pursue a Municipal Fiber-to-the-Node network for fiber and broadband expansion; and
  2. Expand Wi-Fi to unserved City facilities and discontinue consideration of City-provided Wi-Fi in commercial areas.
- **Title: *Work Plan for Fiber-to-the-Premises and Wireless Network (ID # 7616)***  
<https://www.cityofpaloalto.org/civicax/filebank/documents/61084>

The Council passed a Motion directing staff to:

- A. Develop a business case for a municipal-provided Fiber-to-the-Node (FTTN) network for fiber and broadband expansion ("Option 2"); engage a management consultant to develop the business case, funding plans, identify potential partners and/or service providers, and high level network design; and engage an engineering firm to design a FTTN network including an expansion option to build a citywide Fiber-to-the-Premises (FTTP) network; and
- B. Expand Wi-Fi to unserved City facilities and discontinue consideration of City provided Wi-Fi in commercial areas; and
- C. Expediently return to Council with Ordinances that will lower the City's FTTN construction costs such as a Dig Once, String Once, Multi-unit housing, and Microtrenching.

### **Next Steps**

Staff has been working with the CAC in preparing a Request for Proposals ("RFP") to retain a management consultant to complete the above-noted items in the Council's directive. It is anticipated the RFP will be issued in the first quarter of 2018. Staff has also been engaged in exploratory discussions with third party telecommunication firms regarding potential fiber and wireless deployment plans and public-private partnership opportunities. Staff is also developing staff reassignments and seeking UAC feedback to expedite advancement of Council's motion.

### Wireless Projects

- On November 30, 2017, a Request for Proposals (RFP) was issued by the Office of Emergency Services (OES) for a Mobile Broadband Network for Public Safety ("in-vehicle" mobile broadband access). The Fiber/Wireless Core Team worked with OES staff and wireless consultant to prepare the RFP. Final bids were due on December 18, 2017, but no bids were submitted. Staff is evaluating next steps.
- Expansion of OES Point-to-Multi-Point Network: OES and the Fiber/Wireless Team are working to finalize a site in the Montebello Reservoir area to locate a pole for additional equipment to improve the coverage of the existing OES network.
- Based on an August 21, 2017 Council Motion, a project was initiated to expand the City's *OverAir Wi-Fi Hotspots* to specific unserved City facilities at portions of the Cubberley Community Center, Lucie Stern Community Center, the café at the Golf Course and Lytton Plaza.