CITY AND COUNTY OF SAN FRANCISCO
BOARD OF SUPERVISORS
BUDGET AND LEGISLATIVE ANALYST
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Policy Analysis Report

To: Supervisor Farrell

From: Budget and Legislative Analyst's Office

RE: Fiber Network Asset Management

Date: December 3, 2015

Summary of Requested Action

Your office requested we survey City departments to catalogue their fiber network assets and assess the management of these assets.

For further information about this report, contact Fred Brousseau at the Budget and Legislative Analyst's Office.

Executive Summary

- The City maintains high-speed fiber optic networks to provide Internet connectivity to City departments and electronic connectivity within and between departments. Some or all of these networks could potentially be expanded, or their excess capacity leased out, to help defray the costs of any future expansion of the City's high speed network for use by City residents and businesses.
- Detailed, centralized electronically accessible summary information about all City network assets is critical to facilitating high-speed fiber optic network expansion, according to industry representatives and best practices. Within the City, however, responsibility for network assets is dispersed among and within various City departments and information on the assets is incomplete and kept in different databases, including paper records in some cases.
- Network assets include fiber strands and cables, conduit, utility poles, and networking facilities. Network asset inventory data should ideally include: 1) miles of fiber and conduit, and 2) asset location, condition, ownership, and access points. Though City departments are able to estimate fiber cable lengths under their control, they do not have centralized, comprehensive geospatial data detailing location, condition and other characteristics that should be tracked according to industry best practices.
- The City's fiber assets are mostly managed by the Department of Technology (DT) but the conduit in which the fiber is located is mostly owned and managed by the Municipal Transportation Agency (MTA). In addition to utilizing conduit owned by the MTA, the City's high-speed fiber optic network, City Fiber, also utilizes conduit owned by other City agencies and privately owned conduit provided by PG&E, Astound, and Comcast. Conditions for use of the privately

owned conduit for future City network expansion varies by company and may not be allowable in all cases.

- The City's Public Utilities Commission and Airport own and maintain their own fiber and conduit assets for their Internet access and departmental connectivity.
- The City has extremely limited information on private sector network infrastructure that it currently occupies and that it may wish to use for future expansion of a high speed municipal fiber network. The lack of information makes it difficult to plan expansions of the City Fiber network and to identify points of leverage for any potential public-private partnership to expand Citywide connectivity.

Policy Options

1. The Board of Supervisors should consider developing legislation or a policy to consolidate and standardize data regarding City-owned network assets under a single department or official. Input on implementing this policy, including its costs, should be solicited from the Chief Information Officer, the Chief Data Officer, the Chief Innovation Officer, the Committee on Information Technology, the Department of Technology, the Municipal Transportation Agency, San Francisco Public Works and the Public Utilities Commission.
2. The Board of Supervisors should consider developing legislation or a policy for a single department or official to collect data on privately owned fiber assets within City limits.
3. The Board of Supervisors should request that City staff work with private owners of network assets to provide the City up-to-date and detailed GIS data on their assets so that they can be integrated into any City fiber network expansion planning process. Any safety and/or business privacy concerns could be addressed through agreed upon limitations on content access, which is standard for GIS databases. City staff should also work with private asset owners to resolve uncertainties or restrictions on future use of private sector conduit the City presently occupies.
4. The Board of Supervisors should include provisions in the recommended policies or legislation that all network asset data be publicly available and kept up-to-date to facilitate any future expansion of a municipal or privately owned fiber network.

Project staff: Fred Brousseau and Nicolas Menard

Background

The City and County of San Francisco (the City) maintains high-speed fiber optic networks to enable electronic communications between and within City departments and to provide departments with Internet access. Though mostly used for municipal purposes, some of the City's excess network capacity is leased to nonprofit organizations for non-municipal uses. While much of the network assets are under the jurisdiction of the Department of Technology, the conduit in which the fiber is placed has various public and private owners. In addition, the Public Utilities Commission (SFPUC) and Airport own and maintain their own fiber and conduit assets for their Internet access and intra-departmental connectivity.

The City's existing fiber networks could potentially be leased out, to the extent they have excess capacity, or expanded, if the City elects to construct a municipal broadband network in the future to provide high speed Internet access to City residents and businesses. Such leveraging of City resources would help minimize network expansion costs.

To determine the extent of City network assets potentially available for uses besides municipal operations, the Budget and Legislative Analyst surveyed City departments to obtain and compile inventories of their network assets. Departments were requested to identify the types and quantity of network assets under their jurisdiction.

Municipal Network Management Best Practices

The information collected from City departments was assessed against network asset management best practices developed by the consulting firm CTC Technology and Energy.[1] These best practices were developed for use by municipalities in managing their assets and to facilitate expansion of municipal networks for other uses, such as high-speed fiber networks for residents and businesses, whether publicly or privately owned.[2] CTC recommends documenting all publicly owned network assets to capture and publish the following attributes:

- Location of fiber strands, conduit, and poles

[1] The City has contracted with CTC to identify conduit sites for the implementation of the "Dig Once" ordinance. The firm has also performed two municipal fiber feasibility studies for the City in 2007 and 2009 and for numerous other municipalities and state and local government entities throughout the U.S.
[2] Joanne Hovis and Andrew Afflerbach, "Gigabit Communities: Technical Strategies for Facilitating Public or Private Broadband Construction in Your Community", CTC Technology and Energy. January 2014.

- Fiber strand counts
- Whether fiber is aerial (on utility poles) or underground, and spatial location of fiber on poles and underground
- Location of access points for fiber strands and conduit
- Conduit color
- Conduit condition
- Conduit capacity
- Conduit path
- Conduit design specifications
- Conduit ownership

CTC also recommends that municipalities develop a centrally managed and public database of privately owned network assets, such as fiber, conduit, utility poles, streetlights, and existing underground utilities as well as street attributes, including addresses, rights of way, building footprints, parcels, and neighborhood boundaries. According to CTC, detailed data on private assets would allow a new or existing Internet Service Provider to: (1) identify leasable resources, (2) develop accurate forecasts of construction costs and timelines, and (3) reduce time needed for fieldwork to plan network design.

CTC recommends the network asset data be formatted so it can be managed and available for analysis in a Geographic Information System (GIS) database. GIS data can be used to develop highly detailed maps of network assets and is a widely used data strategy in both the public and private sectors. Thus, comprehensive GIS data on its network assets would enhance the City's ability to expand or lease City Fiber. More comprehensive data also improves the ability of Internet Service Providers (ISPs) to plan and swiftly deploy new network resources.

Overview of City Departments' Network Assets

Exhibit 1 below summarizes the City's network assets and controlling departments. As shown in Exhibit 1, ownership of City-owned network assets is spread among several departments. Assets controlled by the Airport are all located on Airport property and thus not contiguous with the rest of the City.

Though most departments are able to report the number of miles of fiber that they own and manage, they do not collect comprehensive network data, as recommended by CTC. As a result, it is not easy to report the extent of City network assets that could potentially be used to expand the City's network for non-municipal use in the future. Besides the usefulness of such information for

potential network expansion, maintaining a complete and accurate inventory and measurement of the condition of all assets is a best practice for municipalities.[3]

The Department of Technology (DT) provides Internet connectivity to many City departments through City Fiber, the City's municipal fiber network. DT installs and maintains fiber that connects City buildings with the Internet. City departments generally manage connectivity within their own buildings. Because City Fiber is not ubiquitous, some departments supplement their connectivity needs by purchasing service through the City's master contract with AT&T.[4] In addition, the San Francisco Public Utilities Commission (SFPUC) and the Airport manage their own fiber networks that provide connectivity among their facilities and to the Internet.

DT manages fiber but does not own conduit. Instead, ownership of the conduit used for City Fiber is dispersed among other City departments, mostly the City's Municipal Transportation Agency (MTA), and some private companies. Utility poles on which an aerial network could be deployed are owned by the Municipal Transportation Agency (MTA) and the Airport.

Exhibit 1: Summary of City Network Assets, by Department

Department	Fiber	Miles of Fiber	Miles of Conduit	Utility poles
Department of Technology	Yes	194.2	Unknown	None
SF Public Utilities Commission	Yes	29.0	Unknown	None
Municipal Transportation Agency	Yes	37.0 (partial)	Unknown	20 - 30
Airport	Yes	Not Reported	Unknown	2,016

Source: Budget and Legislative Analyst Survey of City Departments

Exhibit 2 below summarizes each department's record keeping regarding its network assets. As shown, none of the departments' practices are consistent with the best practices identified in the CTC report cited above as City departments do not collect all of the data recommended, the data is not stored in a GIS compatible database, and the data is not centrally maintained or easily accessible.

[3] See "Asset Maintenance and Replacement" Best Practice Advisory, Government Finance Officers Association, March 2010.
[4] The AT&T contract also provides telephone service and telecommunication consulting services.

Exhibit 2: Summary of Departments' Network Asset Management Methods and Tracking,

Dept.	Asset	Asset Mgmt. System	GIS System?	What is Tracked	Limitations	Consistent with best practices?
DT	Fiber	ArcFM, (GIS)	Yes	Cable routes, fiber strand counts	ArcFM does not contain data on currently occupied conduit, individual fiber strand availability, or detailed location data.	No
DT	Conduit	Paper records	No	No digital data tracked		
SFPUC	Fiber	Engineering diagrams	No	As built diagrams, schematics	The Department does not digitally track location and other data recommended by CTC regarding its fiber and conduit networks.	No
SFPUC	Conduit	Engineering diagrams	No	As built diagrams, schematics		
MTA - Video Shop	Fiber	Engineering diagrams	No	Location	Besides location and design, MTA's Videoshop does not track data recommended by CTC. The information is not digital.	No
MTA - Video Shop	Conduit	Engineering diagrams	No	Location		
MTA - Video Shop	Poles	Engineering diagrams	No	Location		
MTA - Networking Team	Fiber	DT	Use DT	Cable routes, fiber strand counts	MTA's Networking Team utilizes DT's City Fiber network and relies on DT to track data on those assets (see DT limitations above)	No
MTA - Networking Team	Conduit	DT	Use DT	No data tracked		
MTA - Sustainable Streets	Fiber	DT	Use DT	Location, route, strand counts	MTA's Sustainable Streets Division utilizes DT's City Fiber and relies on DT to track data on those assets (see DT limitations above)	No
MTA - Sustainable Streets	Conduit	DT	Use DT	No data tracked		
MTA - Motive Power	Fiber	DT	Use DT	Location, route, strand counts	MTA's Motive Power Division utilizes DT's City Fiber and relies on DT to track data on those assets (see DT limitations above)	No

Dept.	Asset	Asset Mgmt. System	GIS System?	What is Tracked	Limitations	Consistent with best practices?
MTA - Motive Power	Conduit	DT	Use DT	No data tracked	(see above)	No
AIR	Fiber	NewNet CMS	No	Location, size, utilization	System does not track older portions of the network.	No
AIR	Conduit	GIS	Yes	Location	Available capacity of conduit is not tracked.	No

Source: Budget and Legislative Analyst survey of City departments

Department of Technology

DT's City Fiber network contains 194.5 miles of fiber cables, providing connectivity to City facilities and to San Francisco Housing Authority public housing developments. As stated above, although the Department installs and manages the network, it does not own or manage any of the conduit in which the fiber is located or utility poles upon which fiber cables are mounted.

DT maintains limited digital data on City Fiber: fiber routes and strand counts are maintained in a GIS database. A separate program tracks connections between network elements (such as access points and switches). However, individual fiber strands in use are not digitally tracked, which makes it difficult and time-intensive to know precisely how much fiber is available at a given location and could potentially be expanded for a municipal network.

DT does not maintain a Citywide database of available conduit nor, as explained more fully below, does it keep a digital record of all the conduit it presently occupies. No other City department has such records either.

As mentioned above, City Fiber utilizes both City-and privately-owned conduit. Arrangements for City use of the privately owned conduit varies by company and its potential use for an expanded City network for non-municipal purposes is subject to uncertainty. Use of privately owned conduit is typically restricted to "government use", or connecting government facilities only. Commercialization of City Fiber, such as leasing some of the network to private Internet Service Providers or to other companies, may not be allowable on portions of the City network that run through privately owned conduit. Because the Department does not keep digital records of the conduit it occupies, it is difficult to know how much of the network may be available for potential commercialization. DT is planning to record conduit information going forward as part of implementation of the City's

Dig Once program. As part of that effort, DT also has plans to populate historical data on conduit it has utilized.

DT reports it does not publish detailed maps of its fiber network due to public safety concerns. However, these concerns could potentially be addressed by limiting certain database content (such as location of switches) to certain users. This is a standard tool offered in most GIS databases.

San Francisco Municipal Transportation Agency (MTA)

The MTA has a substantial network of underground conduit and controls a limited amount of fiber and utility poles. MTA does not maintain a central database on all of its fiber, conduit, or utility poles and cannot report the number of miles of conduit under its jurisdiction or details on its utility poles. Information on the MTA's network assets is spread among four divisions.

MTA's Videoshop Division[5] maintains paper records on its network assets, which only include the location and design of fiber, conduit, and poles used for video monitoring. A portion of the network is maintained and monitored by DT and subject to its record keeping practices while the portion of the network that was originally installed by MTA continues to be managed exclusively by MTA. Detailed information about these assets is not tracked in a digital asset management system, as recommended by CTC.

The MTA's Networking[6], Sustainable Streets[7], and Motive Power[8] divisions all rely on DT to maintain their fiber networks and are subject to DT's record keeping practices. Thus, there is limited or no digital information available on fiber strands or their availability at a given location and other attributes of conduit used by these three MTA divisions.

MTA reports it is in the early stages of implementing an agency-wide enterprise asset management system (EAMS). The EAMS will include GIS data on fiber and conduit controlled by MTA. The Agency reports it is currently in the process of

[5] The MTA's Video Shop provides preventive maintenance and repairs to cameras and DVRs on revenue vehicles and at facilities, platforms and stations.

[6] The Networking Team, part of MTA's Information Technology group is composed of architects, engineers, installs and maintains networking services for the MTA, including MTA's Enterprise Network interconnecting its facilities, and interacting with other third-party networks and the Internet.

[7] The MTA's Sustainable Streets Division provides planning, engineering, and operational improvements to the city's street, transit, bicycle, pedestrian and parking infrastructure.

[8] The MTA's Motive Power Division operates and maintains the Traction Power Substations, the cross-connects and the dedicated high voltage supply lines to provide propulsion for electric transit vehicles.

defining the data requirements for these assets and therefore has not finalized what data the EAMS will track. In addition, MTA reports it has a GIS Working Group that is inventorying the agency's current GIS capabilities and planning for the agency's future GIS needs.

Public Utilities Commission (SFPUC)

The SFPUC reports that its Wastewater Enterprise has approximately 29 miles of fiber separate from City Fiber that electronically connects its facilities in San Francisco to each other and to the Internet. The SFPUC installed a conduit network of unknown capacity within the City as part of its Wastewater Enterprise capital improvements that began in 2008.

The SFPUC maintains location and design information on its fiber and conduit networks in engineering diagrams. These diagrams show the system "as-built" and do not reflect any system updates since installation. Therefore, it is technically possible but time-intensive to identify excess fiber or conduit that may be available for any future network expansion. The SFPUC does not digitally track information on these assets, as recommended by CTC.

San Francisco Public Works

DT uses conduit secured for the City through a settlement of a claim by SF Public Works concerning a violation of permit conditions. As recommended by CTC, SFPW does publish GIS data on street attributes, including addresses, rights of way, building footprints, parcels, and neighborhood boundaries.

San Francisco International Airport

The Airport maintains a fiber optic network separate from City Fiber to connect its facilities to one another and to connect to the Internet. The Airport maintains GIS databases containing the location and design of its conduit and utility poles. The Airport's conduit data does not contain information on available capacity. Such information is kept in engineering diagrams and is therefore time-intensive to compile. A separate database, NewNet CMS, contains location and utilization information on the Airport's fiber, though older portions of the network are not recorded in that system. The Airport is currently in the early stages of developing a comprehensive infrastructure inventory as part of its development plan. The Airport, rather than DT, owns, maintains, and operates its network and physical infrastructure (conduit, fiber and copper). The Airport does not utilize any DT or other City agency infrastructure for its operations.

Private Assets

The major private owners of conduit within the City are AT&T, Comcast, and PG&E but there is limited publicly available information on these assets. To the extent that the City has utilized privately owned conduit for its fiber optic networks, it is uncertain whether this conduit could be used if the City's network is expanded to serve City residents and businesses.

In an interview with the Budget and Legislative Analyst's Office, a PG&E representative stated that records of its conduit are a mixture of digital diagrams and paper records. PG&E did not provide data on its conduit within the City.

AT&T and Comcast have not published any detailed information on their fiber assets within the City.

There is no legal requirement for private owners of network assets to provide the data recommended by CTC to the City. The City could possibly work with the private sector companies to arrange for provision of the CTC recommended data to the City. Safety business concerns could be addressed by withholding certain content from public users, a standard tool offered by most GIS databases.

Conclusion

Information on City-owned network assets is limited and dispersed among the Department of Technology, the Municipal Transportation Agency, the Airport, and the City's Public Utilities Commission.. Each department has its own record keeping practices and many records are maintained in static engineering diagrams that cannot be integrated into a GIS database. Data on privately owned network assets is even more limited.

As a result, planning an expansion of a municipal or privately owned network is more time-intensive and expensive than it could be if data on fiber assets were centrally maintained and up to date.

Policy Options

1. The Board of Supervisors should consider developing legislation or a policy to consolidate and standardize data regarding City-owned network assets under a single department or official. Input on implementing this policy, including its costs, should be solicited from the Chief Information Officer, the Chief Data Officer, the Chief Innovation Officer, the Committee on Information Technology, the

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