

STAFF REPORT

DATE: June 4, 2019

TO: City Council

FROM: Broadband Advisory Task Force
Diane Parro, Director of Community and Business Engagement
Sarah Worley, Business Engagement Manager

SUBJECT: Broadband Task Force Final Report

Recommendations

1. Receive presentation and final report from the Broadband Advisory Task Force (BAT Force) on the Residential Broadband Survey report and other efforts (Attachment #1).
2. Receive the staff report and provide direction on next steps.
3. Adopt Resolution acknowledging appreciation of their service and dissolve the Broadband Advisory Task Force (Attachment #2).

Fiscal Impact

The expenditure of \$9,000 for consultant services to prepare the residential broadband survey was included in the original \$86,000 from Cable Franchise Fund, approved by Council on April 18, 2017. Indirect costs include staff time to support the efforts Task Force beginning prior to December, 2015 and covering 33 meetings of the BAT Force. Costs to implement any additional studies or recommended next steps are not yet determined.

Council Goal(s)

Council Goals: Drive a Diverse and Resilient Economy and Fund, Maintain and Improve Infrastructure, and Ensure a Safe, Healthy and Equitable Community.

Background

Over the past four years the City Council has continued taking steps to explore options for improving community access to broadband, including:

2015 - Yolo Broadband Strategy, Davis Broadband Plan and formation of Broadband Advisory Task Force

2016 – Citywide Fiber Optic Network Feasibility Study RFP

2017 – CCG Consulting/Finley Engineering Inc. Consultant Services Agreement to prepare Broadband Feasibility Study

2018 – Receive Broadband Feasibility Study report and expand the scope of the task force to include conducting a survey assessing residential interest in a municipal broadband network and gaining information about the potential for owners/managers of multi-dwelling units to choose service providers.

For these past three years, the Broadband Advisory Task has focused a considerable amount of time and effort to explore the ways in which the City could provide better community access to broadband. The group identified a municipally-owned network as the superior model based on the potential to provide greater choice and level of service but also dismantle the digital divide that for-profit providers have created in our community.

The benefits of such a network include the following:

- Increased economic development potential of having this telecommunications infrastructure in place
- Support for telemedicine enhancements
- Ability to support Smart City/Smart Grid requirements including Public Safety initiatives
- Increased educational opportunities for K-12 as well as off-campus university research
- Provision to every premise dissolves the digital divide

On April 3, 2018, Chris Clements, Chair of the Broadband Advisory Task Force presented findings from the Broadband Feasibility Study which are included here for your convenience. The entire report is available on the City website under Broadband Advisory Task Force or use this link. [Broadband-Feasibility-Study-Final-Report-2018-04-03](#) Broadband Feasibility Study Executive Summary Report Attachment #3)

- Davis has the same kind of broadband as most cities – fast, but relatively expensive.
- There are a few broadband access gaps – e.g. some low income households, and downtown businesses.
- There are major benefits from fiber broadband including economic, safety, energy, climate preparedness, transportation, health, and education. There are also numerous risks such as low revenues requiring need for substantial ongoing public subsidies, and durability and longevity of long term partnerships.
- High cost of recommended underground, dual fiber construction, and high California wages combined with prevailing wage requirements if public funding is used, make achieving a citywide fiber network a challenge.
- The City partnering with a single network operator looks like the best financial scenario if a project were to proceed..
- Financing the network will require funding from tax revenues other than bonds.
- There are some intriguing scenarios for building fiber to everybody, e.g. increased tax financing could allow offer of a basic, low cost internet service citywide.
- Open Access looks difficult to justify because estimates of revenues generated will be insufficient to support multiple provider operation costs.
- The apartment market is already competitive and will be a challenge to penetrate.

The study represented a first look at a project from an engineering and cost angle and the issue that surfaced repeatedly was cost. After evaluation of multiple business models, the “Single Provider” scenario was considered the best fit for Davis. This represents a scenario where there is one network operator (could be the city or another entity); the business has a 50% penetration of homes, businesses and organizations, and multiple dwelling units (MDUs) in the market.

\$72.0 M to construct the fiber network

\$34.3 M to provide network connections & and broadband service

\$106.7 M Total Cost

Follow-up Study Findings

The task force remained in place following completion of the feasibility study to pursue two lines of inquiry that are important to complement the findings of the feasibility study.

First, the task force worked with CCG Consulting to conduct a scientific poll with a sample of over 350 Davis residents with a goal of gaining a better understanding of the potential “take rate” or what percentage of our residential population would switch from a private broadband provider to a municipally-owned network. The results show 21% of homes said they would definitely buy broadband from a new City fiber network, with another 31% saying they would probably buy, and 30% saying they might buy. This is significantly lower than what the consultants have seen in many other markets. 78% of respondents said they could be lured to a new network by lower prices, 62% by faster speeds, and 43% by better customer service. 18% said they would definitely not consider moving. (Attachment #4)

In addition, a local advocacy group, DavisGig conducted a self-selecting survey through social media. The results show net neutrality and privacy were very important and almost all respondents supported the statement, “Assuming the City could find a way to pay for it, would you be in favor of the City building a fiber optic network that could offer fast Internet Access to every home and business in the City?” (Attachment #5)

The task force explored the issue of multiple-dwelling units through a series of conversations with owners of MDUs. No significant barriers were mentioned that would preclude a switch on behalf of all their units to a new provider if a better option became available.

Current Task Force Recommendations

The task force had a facilitated conversation with all but one member present which resulted in the final update letter, (Attachment #1), which was approved by a unanimous vote. The group remains committed to a municipal fiber network for all the reasons noted. They willingly acknowledge that this group has served its purpose and while they ardently recommend active engagement on behalf of community members in any future phases of exploration of broadband, the group agrees it does not have the level or type of technical expertise that would be desirable.

The perspective of the Broadband Advisory Task Force is that implementation of a municipal broadband network could best be moved forward through further exploration of financial options and a technical study based on a phased approach to complete deployment of fiber to every premise.

Other Considerations

The benefits of a municipally-owned fiber network to every premise are numerous and exciting. However, there are significant barriers to implementation which deserve consideration and they include the following:

- The cost estimated in 2017, not adjusted for cost increases or inflation, for a Fiber-To-The-Premise (FTTP) network is over \$100 million for construction. The estimate is conservative and initial outlay could be reduced by phasing the project, but that would also delay the full benefit of the project to the entire community.
 - The follow-up residential broadband survey did not provide verification of solid strong demand. At a take rate of 50% (used in the modeling) the network would not breakeven and would require additional funding of an estimated \$53.9 million

on top of construction and ongoing staff/maintenance cost during the 25 year span of the project.

- The cost estimate does not include operation of the network. The City would embark on the creation of a new service utility that would require staffing and maintenance resources, or enter in to an agreement with an outside provider for those services. The City does not possess the appropriate expertise or bandwidth to take on such an endeavor and would require creation of such internal resources to run a municipal system. Alternatively, additional staff resources would be needed to manage contract(s) with other entities to run such a system on the City's behalf.
- Consumer's desire for low pricing would be problematic if private providers existing in this marketplace undercut the pricing introduced by a municipal network as has been experienced in some situations in other locations thereby preventing the municipal network from converting subscribers. A phased project might be designed on the premise of early subscribers funding next stage implementation which could be thwarted by price undercutting, thus preventing the extension of the network to other areas.
- The ever-changing regulatory environment is currently trending toward increased support for large corporate providers and reduction of control for local entities.
- Advances in technology are rapid and while a fiber optic network is currently predicted to be the most enduring investment of this kind future technological advances may disrupt existing service models, or provide additional competitive options. Already, some service providers are exploring the use of 5G wireless technologies to offer residential broadband service, incumbent broadband providers continue to make incremental improvements to their technologies and bandwidth, and significant resources are being invested to explore and test satellite-based broadband options. Balancing a large capital investment with long payback schedules with a rapidly evolving technology environment brings the efficacy of said investment into greater doubt.

Conclusion

Pursuit of increased bandwidth and access (via broadband) to information and data sharing is an important tool to support the pursuits of our community members and to facilitate expanded economic development. There is little question that expanded broadband capabilities would be of benefit to Davis. The primary question then becomes the method of infrastructure development and service delivery and how to do so in a way that is equitable, reliable, and cost effective. The analysis undertaken to date has focused on municipal (e.g. City owned and operated) broadband as the means to improve service delivery.

This analysis points to critical challenges with the financial viability and long term technological efficacy of a municipal broadband network and does not provide an apparent path to overcome these fundamental challenges. This is not to suggest that we discontinue the pursuit of the goals of increased broadband capabilities. Rather, it may suggest that all options, including alternatives to a municipal broadband network, be further explored as a means of achieving the desired goals.

Next Steps

Staff recommends that Council members adopt the resolution acknowledging appreciation of

their service and dissolve the Broadband Advisory Task Force final report from the Broadband Advisory Task Force and thank them for their good work.

In addition, there are several ways that staff suggests that the City can continue efforts toward improving community access to broadband that do not require implementation of a municipal network. These include the following:

- Continue inclusion of conduit in City projects whenever financially viable.
- Encourage commercial developers to incorporate telecommunications infrastructure and additional conduit for future connectivity as an integral part of the project plans.
- Continue to partner with UC Davis, DJUSD and Yolo County on all projects that can provide mutual benefit.
- Gauge interest from private broadband service providers to invest and upgrade service capabilities in Davis, with a particular eye toward bridging existing infrastructure and service area gaps and development of service options for low income households.

If Council would like to continue exploration of a municipal network, general direction is requested at this time. Based upon the level of interest, prioritization of this project, and allocation of City resources, staff would return to Council with plans, staffing needs and cost estimates for future work.

Attachments

1. Broadband Advisory Task Force City Council Recommendations Letter
2. Resolution Acknowledging Service and Dissolving Broadband Advisory Task Force
3. Executive Summary/Report Summary Excerpts from Final Draft Broadband Feasibility Study (pages 4-16)

Web link to full Final Draft Broadband Feasibility Study report

<http://documents.cityofdavis.org/Media/CityCouncil/Documents/PDF/CityCouncil/Broadband-Advisory-Task-Force/Documents/Broadband-Feasibility-Study-Final-Draft-2018-03-12.pdf>

4. Residential Broadband Survey Report
5. Excerpt from DavisGig Survey
6. Map of the Study Areas Showing the Proposed Network Design and Fiber Ring



**City of Davis
Broadband Advisory Task Force**

May 28, 2019

Mayor Lee and Honorable City Council Members,

This letter is to serve as a final update on the tasks that the Broadband Advisory Task Force (BATF) requested to complete during the April 2018 update to Council. Before providing the details of the work that task force has been working though, I find it important to stress that the overall consensus of the Task Force is that the time has never been more important than now to take significant action towards this effort. With the empty promises of faster networks, all wireless options, and even dense fiber deployments, it is the community that suffers as these technologies just never seem to penetrate the masses and provide a common platform that all can call their own.

As we hope will be obvious in the details that follow, the BATF would like to reaffirm our recommendation that City Council support the concept of implementing a community owned broadband network in the City of Davis through the next steps as detailed below.

Update on BATF Tasks

At last update, the BATF had asked the Council to support our request to further investigate the community interest towards the concept of a community owned broadband network. This included two direct efforts. The first was to conduct a random survey of the City's population and the second was to interview the owners of the larger multi-family units in the City to better understand their current contractual obligations.

Survey Results

For the survey, Doug Dawson, the consultant hired to help the BATF with the feasibility study, assisted in developing a survey that was used to poll a random sample of the population. The survey itself consisted of over 30 questions and was delivered to over 350 residents of the City of Davis. The results of the statistically valid survey clearly identified three major findings; people in the City want a municipal fiber network, they don't know how fast their internet connection is today, and they feel they are paying too much for what they are receiving in terms of quality of service and throughput.

In addition and with their own funding, Davis Gig, a local grass-roots organization prepared and delivered a survey as well through its social network. The results of which also demonstrate the desire of the community to have a more robust, fairly priced alternative to the commercial networks that are currently available in the community.

Multi-Family Property Manager Contractual Obligations

As we moved into the second phase of this exploration, the focus adjusted slightly to capture the opinions of the rental property owners, schools, public works and businesses to identify any contractual or other potential pitfalls with shifting services to a community owned network. When the larger multi-family unit owners were interviewed, there were no significant barriers presented

that would preclude them from switching away from their current service provider, should a more robust, less-cost and higher bandwidth option be made available.

When discussing the possibilities with Dr. Bowes, Superintendent of the DJUSD, his excitement over having a reliable network that could be used for administrative staff as well as be a platform to provide a media-rich teaching environment was clearly displayed. Further, several business owners have presented their perspectives as to why a fiber rich network is critical to remain competitive with the Silicon Valley giants that have more than ample bandwidth at their disposal.

Next Steps

In order to move the project forward, it will require technical expertise beyond the volunteer BATF composition. The areas that were identified are the technical details and scoping of the network as well as the funding options. Below are the BATF perspectives on both of these items.

Financial Exploration

Throughout the majority of the analysis that was performed by the BATF, one message was recurring more than any other. That was the need to spend some time and effort to understand the financial options that could be used to make this program a success. For this work to be completed with a level of confidence that is needed to move the project into a deployment phase, it will be critical that an expert in alternative financing options be consulted. BATF members informally met with a local government finance expert who indicated there are realistic options on how the City could finance such a project. It is the recommendation of the BATF that the City engage with someone with background and expertise in order to understand the financial possibilities that will make the deployment possible

Technical Details/Phasing

In an effort to not only reduce the overall effort required but also to reduce the upfront costs associated with the build out of the network, it is a recommendation of the BATF that the City deploy the project through a phased approach. Taking this approach would allow the core of the network to be built and put into service while work is done to construct and deploy the other parts of the network. As the different phases are put into service, the communities served by the earlier phases will be a natural mechanism for showcasing the benefits and success of the network. It has been shown in other cities, this publicity often builds excitement that is not obtainable if the entire network is built in one phase.

From a starting point, the most natural option would be to investigate the network requirements and connectivity needs that are essential to satisfy the data needs once served by the iNet network. This will afford the city a first-hand account of the power a fiber network will provide the rest of the community. In addition, it sends the message that the City is willing to support the project to the extent it is using the network on a daily basis to run the City. From there, building the network around anchor tenants such as the downtown core and Davis Joint Unified School District would be critical next steps in the phasing. The footprint of the school district also provides a very natural demarcation of how neighborhood rings could be constructed and deployed.

As with any major undertaking, the devil is in the details. Building a new fiber network is no different. Because of this fact, it is imperative that a technical group inclusive of the City engineers

be put together to review the options that will detail the network build out. Once the network design and electronics are defined, the group can then develop a rough order magnitude quote that can be used by the team identified above to investigate the financial options. This will not only allow for the accurate accounting of the costs related to the various components like trenching, equipment procurement and maintenance costs, but also the cost associated with being in the network provider business like installation services and emergency operations.

Conclusion

While the BATF prepares to disassemble, the emotion and passion around the concept of a municipal fiber project could not be any more intensified. We strongly feel that with the right combination of technical engineering, financial exploration and residents with relevant expertise, not only will the City be successful in deploying this utility to the community, but would also pave the way for massive economic development. The network would create the ability for businesses around the world to employ work from home professionals in the City of Davis. The University would be able to promote work from home programs and provide parity to its students who currently experience a massive divide between the campus and home networking experience. It would create the ability for elementary and high school students to complete their coursework at home and not have to go back to the school library to be connected. These are just a few of numerous examples of how the community would benefit from such a powerful utility and they all point back to you, Mayor Lee and Councilmembers, to take the next step.

Being a pioneer is never easy work. It takes vision, desire and perseverance. Attributes that the City has demonstrated over the years and that make me proud to be a part of this community. On behalf of the entire Broadband Advisory Task Force, I would like to extend our complete and sincere gratitude for your support. It has been a very informative and rewarding project to be part of and we look forward to you working through the details set forth to deploy what would truly be one of the most forward thinking and innovative projects the City has undertaken.

It is with this statement that we close this effort: What will you do when bandwidth is not a constraint?

Sincerely,

Chris Clements, Chair
Broadband Advisory Task Force

RESOLUTION NO. 19-____, SERIES 2019

**RESOLUTION RECOGNIZING SERVICE AND DISSOLVING
THE BROADBAND ADVISORY TASK FORCE**

WHEREAS, on December 1, 2015, the City Council of the City of Davis adopted Resolution 15-167 Series 2015 forming a Broadband Advisory Task Force; and

WHEREAS, the Broadband Advisory Task Force was formed to explore options to improve community access to broadband service; and to examine various models of broadband delivery; explore business models; and make recommendations to the City Council on next steps; and

WHEREAS, the Broadband Advisory Task Force worked tirelessly for 3 years and 3 months beginning in March 23, 2016; hearing knowledgeable guest speakers; participating on subcommittees; undertaking preparation of a Broadband Feasibility Study to understand the potential of creating a municipal fiber network in Davis capable of providing broadband service to every premise; including identifying a potential network design and evaluating a range of business models to identify the best approach for Davis; and

WHEREAS, the Broadband Advisory Task Force in presenting feasibility study findings and recommendations to the City Council in April 2018, was authorized to conduct two additional tasks: a Residential Broadband Survey, to assess interest in a municipal broadband network; and to conduct interviews to identify impediments to participation from multifamily projects; and

WHEREAS, the Broadband Advisory Task Force has presented its findings from these efforts and recommended next steps for exploration of a municipal broadband network to the City Council; and

WHEREAS, the Broadband Advisory Task Force has completed its charge, the Mayor of the City of Davis and fellow City Council members wish to acknowledge the service the task force members and successors have provided and thank them for their contributions: Chair Chris Clements - UC Davis, Vice-Chair Christine Crawford, Yolo County Broadband Working Group, Jeff Mischkinisky - DavisGig, Mike Adams and Matthews Williams, Davis Community Network, Autumn Labbe-Renault - Davis Media Access, Jacques Franco and Lorenzo Kristov - Utility Rate Advisory Committee, Marcia Bernard - DJUSD, Christina Blackman, Jennifer Nitzkowski and Carolyn Stiver - Davis Chamber of Commerce, Stephen McMahon - Community Representative, Scott Adler - Community Representative.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Davis does hereby dissolve the Broadband Advisory Task Force, effective immediately.

PASSED AND ADOPTED by the City Council of the City of Davis on this 4th day of June, 2019, by the following vote:

AYES:

NOES:

Brett Lee
Mayor

ATTEST:

Zoe S. Mirabile, CMC
City Clerk

Executive Summary

CCG Consulting (CCG) and Finley Engineering submit this report of our findings and recommendations from the feasibility study conducted to understand the potential for bringing a fiber broadband network to Davis. Our two firms looked at the feasibility from a number of different angles. Finley Engineering estimated the cost of building fiber everywhere in the city using two different fiber electronics technologies. CCG undertook research that told us more about the competitive landscape in the city that included a) research on existing competition and the incumbent broadband providers, b) discussions with key broadband stakeholders in the city, c) an analysis of actual customer broadband bills, and d) the results of speed tests taken by Davis citizens that measured their actual broadband speeds. Next, CCG created numerous financial projections that looked at different business plan scenarios for operating a broadband network in the city. Finally, the study answered various questions asked by the original RFP such as defining the benefits and risks of having a fiber network in the city.

The key finding from our analysis is that it doesn't look feasible to build and operate a fiber network and business in the city that would be 100% funded by a single bond issue. Instead, it looks like the only viable way to finance a fiber network would be to fund some portion of the new network with some other form of funding, such as tax revenues derived from sales taxes, property taxes, or some other source of municipal revenue.

There are a number of reasons for this finding. First, the cost of building a network in Davis is high for various reasons including: a) the condition of poles, which means that the network will have to all be buried; b) the high housing density in the city adds to the cost; and c) high wages in the area mean expensive fiber construction (which is primarily driven by labor costs). The high construction costs then create high debt costs if the project is 100% bond-funded. Operating costs also look to be high in the city, driven again by high labor rates. However, even with higher construction and operating costs, the rates that can be charged to customers are no higher than in other parts of the country, meaning that a fiber business in the city will achieve average revenues but will incur higher-than-average costs.

Nevertheless, there are significant benefits from fiber that make it worthwhile to explore if there are feasible ways to move forward. As DSL broadband on the AT&T telco network continues to decline in the market, Comcast will become more of a monopoly broadband provider in the city. There is ample national evidence that having a second fiber network provides customers with choice and holds down prices compared to communities without a competitive fiber network. The study found some intriguing options for a city network that might enable the city to find ways to address the digital divide and bring broadband to all households in the city. The study explored numerous business operating structures and, since the city doesn't want to be a retail ISP, the best option looks to be partnering with a single operating ISP to operate the business. The option of open access—allowing multiple ISPs to operate on the network—doesn't look to be financially viable.

This report makes a number of specific recommendations on next steps for the city to consider if it wants to further explore fiber broadband options.

Report Summary

Project Overview

Project Description. Finley Engineering and CCG Consulting were hired to do a feasibility study for bringing fiber broadband past every home and business in the community. The project included a number of components including 1) a market analysis of the current products and prices offered in the market, 2) an engineering analysis and estimate of the cost of building and lighting a fiber network, 3) a discussion of the possible operating models to be considered to operate a government-sponsored fiber business; 4) the development of various financial business models to quantify the operating costs and potential profitability of the various operating models, 5) a sensitivity analysis to quantify the impact of varying the most important assumptions and variables supporting the financial models, 6) a discussion on possible funding mechanisms that can be used to fund fiber, 7) an analysis of the likely competitive response of the incumbent providers, 8) the benefits to the community from operating a citywide fiber network, and the financial and execution risks that must be considered. The study culminated in this report which describes the steps taken to meet those goals, a description of the significant facts we found that will influence a decision to pursue fiber, and a list of specific recommended next steps to take next after completion of this report.

Fiber Network Design. Finley Engineering considered several designs before designing a reasonably efficient network for bringing fiber to the whole community. The network consists of a series of huts that house electronics that are connected to a fiber ring to provide redundancy and to protect the network from failure in the case of a fiber cut (see map on page 142). Finley considered both passive optical technology (PON) and active Ethernet technology (AON) – the two primary technologies used to serve fiber to a community. The base analysis is based upon active Ethernet. The network built from the neighborhood huts to reach customers is designed for flexibility and each customer has a separate fiber connection back to a hut. This means that today either of the core technologies can be used to serve any individual customer and this design makes the network ready for future fiber technologies as they are developed.

The full cost of the assets need to operate the network are as follows. This represent a scenario where there is one network operator (could be the city or somebody else), and the business has a 50% penetration of homes, businesses and MDUs (multiple dwelling units) in the market. These figures represent the assets in place by the end of the fourth year after launching the business – the date by which all of the customers will have been connected to the network:

	50% <u>Penetration</u>
Vehicles	\$ 231,800
Tools	\$ 80,000
Buildings	\$ 2,181,440
Furniture	\$ 25,500
Computers	\$ 55,265
Voice Gateways	\$ 245,940
Data Servers	\$ 102,500

Cable TV	\$ 1,053,926
FTTH Electronics	\$ 11,946,563
ONTs	\$ 6,650,091
Fiber Drops	\$ 10,584,956
Fiber Network	\$ 65,864,087
Fiber Contingency	\$ 6,566,409
Elect. Contingency	\$ 406,775
Inventory	\$ 350,000
Capitalized Software	\$ 395,670
Total	\$106,742,422

Note that the required assets vary according to the number of customers connected the network as well as by the number of employees required for the various scenarios that were studied.

Business Models Considered. We considered several different operating models:

- Single Provider. This model looks at the cost of operating the business by a single entity. This could be the city or an operating partner chosen by the city.
- Open Access. This operating model would open the network to multiple service providers to use the network to provide products and services to customers.
- Public / Private Partnership. In this operating model the city would partner with a commercial entity which would provide some of the capital needed to build the network.

Our Approach to the Financial Analysis.

- A base model was created for each operating model. We arbitrarily chose a 50% market penetration (the percentage of customers using the network) at 50% for each base model. We don't have any idea how many customers a new fiber business might win and chose the 50% penetration as typical of other municipal and similar commercial fiber overbuilders.
- All projections were built to reflect a 25-year period in order to match the expected time frame for financing with bonds.
- All projections include projected financing costs for borrowing the money needed to build and launch the network. The base studies anticipated financing with revenue bonds that are backed by the full faith and credit of the city.
- The engineering estimates are conservatively high. As an example, we added a 10% construction contingency to the cost of building a fiber network as well as a 5% contingency for the cost of electronics. But the underlying costs estimates of the network are based upon our best estimate that considers the local market conditions in Davis and of California.
- All studies also include an estimate of future asset costs that are needed to either connect future customers or to maintain and upgrade the network over time. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.
- The models all offer the triple play of broadband, cable TV and telephone service. The assumption is that most people buy broadband and far fewer buy the other products. We also project that the customers buying telephone and cable TV will drop over time. The projections also predict a modest amount of margin from other unspecified future

products that might include such things as security, smart home, managed WiFi and others.

- Products were priced at a modest discount from the existing prices of products sold in the market today. The expectation is that the internet speeds offered on the network will be significantly faster than the speeds offered by competitors. The projections include no future price increases.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Again, we based these costs on local Davis conditions including such things as typical salaries and benefit costs in the area.
- Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Study Results

A summary of the financial results of the various scenarios studied is included in Appendix VI, on page 175. That appendix includes a table showing key facts such the cost of building the network under each scenario, the cost and method of financing the scenario and the amount of cash generated by the scenario over 25 years. After the table is a description of the key assumptions made for each scenario studied.

Base Study. The results of the financial projections for building fiber within the city were not as good as the city had hoped for. For example, the cash losses range from \$34.1 million over 25 years at a 60% customer penetration to \$81.4 million at a 40% customer penetration (page 64).

There are several primary reasons for these losses:

- The fiber network is more expensive to build in Davis due to the fact that the network is going to have to be almost entirely buried. The existing utility poles in the city mostly run through yards and it looks to be too expensive to string fiber on most poles.
- Any construction done by the city must be done at 'prevailing wages'. This means at the wages for similar work in the major cities in California. It would be possible to find contractors that pay a lower wage rate – but that is prohibited by law to help ensure that most construction work goes to California companies.
- Much of Davis has a residential density (how close homes are together) like larger cities. In many cases it will be cheaper to build fiber on both sides of residential streets than to bore under the streets to reach homes if there was fiber on only one side. This adds to the construction cost of the network.
- The salaries and benefits for the employees of the business are set at levels reasonable for Davis. But these costs are higher than might be experienced by a fiber network built in another state with lower salaries.

Funding with Tax Revenues. We show that it is possible for a fiber network to be profitable if some portion of the network is built using tax revenues. That might be some external funding source such as revenue from increasing sales tax. Our study doesn't make any assumption about the type of tax revenue used. We calculated the amount of tax revenue needed to reach cash breakeven - that is a scenario where the business always has enough cash to operate during the whole 25-year window of the bond financing. The amount of needed tax revenues varies with the

customer penetration rates and range from \$33 million at 60% penetration rate to \$59.7 million at a 40% customer penetration rate. These results are shown on pages 65-66.

Reasonable Case Study. Many of the assumptions used in the base study were conservative. This is always done in feasibility studies to make certain that the projected costs of entering the business are high enough so that if the project was financed with bonds there would be sufficient cash.

We looked at a ‘reasonable case’ scenario that softened some of the most conservative assumptions. The most significant assumption change was that the construction contingency wouldn’t be needed. Making that kind of change in bond financing would mean doing enough extra engineering before funding to more precisely estimate the cost of the network. The results of this analysis are shown on pages 66-68 of the report.

Compared to the base case described above with a 50% customer penetration, the reasonable case assumptions reduced the amount of external tax financing required from \$37 million to \$24 million.

Open Access. We also explored an open access scenario. This is a scenario where the city builds the network and then allows multiple ISPs onto the network. This network costs the same in an open access network and the big financial difference is that the city collects ‘access fees’ from the ISPs for using the network, while the retail revenues instead go to the ISPs. The other big change is that the city would have only a few employees under this scenario. Staff that supports customers would be hired by the various ISPs.

The losses in an open access scenario are significantly larger than the one-provider scenario shown above. Losses range from \$102.3 million over 25 years at a 60% customer penetration to \$128.5 million at a 40% customer penetration. This is because the lost revenues in this scenario are greater than the efficiencies from having the ISPs pay for the staffing. This scenario is summarized on pages 68-70 of the report.

Public / Private Partnership. A public / Private Partnership (PPP) is a scenario where the ISPs cover some of the cost of the network. There are nearly endless possibilities of how a PPP might be structured. The studies looked at the simplest scenario where the operating ISP funds the assets needed to support employees (trucks, computers, furniture, etc.) as well as the assets at the customer premise including the electronics (ONT) and anything inside customer premises like settop boxes.

This scenario has a significantly beneficial impact on the city’s cash position. The loss at a 50% customer penetration reduces over 25 years from \$53.9 million to \$3.4 million. However, this scenario would be unattractive to an ISP partner which must fund \$11.5 million of the project, with projected losses over 25 years at \$23.2 million. This scenario is summarized on pages 71-72 of the report.

Again, there are many other potential PPP models. But any model that reduces the capital outlay of the ISP operator would shift costs and losses back to the city.

Digital Divide Scenarios. Finally, we considered digital divide scenarios. These scenarios look at the cost to build the network to everybody in the city. They also offer lower prices in order to get more homes and businesses onto the fiber network.

For example, we looked at a scenario where the city would offer a \$10 broadband connection to homes that qualify. That qualification could be done any ways, such as allowing the low-cost connection for the elderly or for homes that qualify for some subsidy program such as food stamps or reduced-price school lunches.

This scenario increased losses over 25 years, but not drastically so. For example, the losses at a 50% customer penetration for unsubsidized broadband customers increased from \$53.9 million in the one ISP partner scenario to \$60.6 million. With a substantial amount of external tax financing this scenario could be cash positive. This scenario is summarized on pages 73-74.

Key Findings

Customers in Davis Have Broadband Options Today. We asked existing customers to take speed tests to see how their achieved broadband speeds compare to what they are purchasing. Speeds on AT&T's DSL network have a maximum speed of 50 Mbps. A significant percentage of AT&T customers are getting less speed than they are paying for. We did find one AT&T customer that was buying and receiving a gigabit broadband connection on fiber.

However, there are customers in the city buying speeds today as fast as 300 Mbps on Comcast. And, unlike with AT&T, customers using Comcast mostly receive the speeds they are subscribing to, and sometimes a little bit more. Comcast says they will be increasing download speeds in the city and that customers will have speeds up to 1 Gbps by the end of 2018. For both providers upload speeds are significantly slower than download speeds.

Recently AT&T has slowed promotions for DSL and many industry analysts think they are now starting the slow process of withdrawing from that business line. The company is instead putting effort into selectively building fiber and there are some AT&T fiber customers in the city today. Over time as the AT&T DSL product diminishes in the city many customers will only have the choice of using Comcast for fast broadband, making them a virtual monopoly.

There Are Some Broadband Gaps in the City. There were several businesses in downtown Davis that were not able to buy the broadband speeds they want, or that are being quoted high prices to build broadband to their location.

The university also identified locations where they would like faster broadband. For example, they buy space in apartments throughout the city for about 600 underclass students and have also located a number of administrative functions in the city. The University says that both of these groups do not share the same broadband experience as the rest of the campus.

Fiber Construction Costs Are High. The most expensive component of building a fiber network is the cost of the fiber that would be built on each street of the city to reach potential customers.

The fiber network is estimated to cost more than \$72 million. The overall costs of building fiber are higher than what we see in some other cities, for the following reasons:

- Because of the nature and location of existing poles it looks like the best design is to bury the entire network. Buried fiber is the most expensive kind of construction; burying the entire network drives up the cost of the network.
- The housing density in Davis adds to the cost of the network. Fiber construction is most efficient in suburban and small towns where there is ‘moderate’ housing density. In Davis some parts of the city are as dense as what we see in larger cities and this adds to the construction cost. For example, there are streets in Davis where it will be necessary to build fiber on both sides of the street to most affordably reach homes.

In general, wages in California are higher than in much of the rest of the country. Since the cost of fiber construction is primary from labor costs this adds to the costs of building fiber.

The Best Network Design Should Be Flexible. The city asked us to provide a network design that would have capacity to provide 1 Gbps broadband speeds to all customers. The base electronics design uses active Ethernet (AON) technology that delivers at least 1 Gbps to each customer location. But the outside fiber network was designed to accommodate both PON electronics and AON electronics for any customer (these technologies are described in detail later in the report). This would allow for delivery of shared or dedicated bandwidth to any customer, as needed.

There are Significant Benefits to Building a Citywide Fiber Network. These include: expanding customer choice; extending opportunity to connect to the University network where needed in the city; offering a chance to address the digital divide issue; provide affordable broadband options; enhance economic development opportunities; and support smart city initiatives. Examples of these initiatives include use of a citywide network of connected devices, smart sensors, and big data analytics to implement new solutions in safety, energy, climate preparedness, transportation, health, and education (see pages 104-108). A citywide network could also enable better outdoor WiFi, reduced city telecom expenditures, and prepare the city for better future cellular networks.¹

But There Are Also Risks. The primary risk is in not performing financially with a city-owned fiber network and creating a situation where the city would have to subsidize the broadband network. There is also a risk that other broadband technologies become available during the long time period required to pay for the network. Finally, there are the risks involved in working with an operating partner and maintaining that relationship for the life of a potential 25+ year bond issue, or other long-term partnership

Partnering with One Service Provider is the Best Option. The financial analysis shows that operating a retail network by partnering with one service provider produces the best financial results. This could be a nonprofit such Davis Gig or a commercial ISP. It would also be possible to partner with a newly-formed cooperative, although a coop would need to find much of their own funding.

¹ <https://obamawhitehouse.archives.gov/the-press-office/2015/09/14/fact-sheet-administration-announces-new-smart-cities-initiative-help>

Financing the Network Will Require Tax Revenues. In the financial analysis we did not find a financial model that could be funded solely with bonds. The only feasible-looking scenarios use some other source of city tax revenues to fund some portion of the cost of the network. For example, if the network was expected to get a 50% customer penetration rate, then \$36.5 million of the funding would have to come from some source other than the revenues of the business.

There are Intriguing Digital Divide Scenarios. There are scenarios where the city could extend fiber to low-income homes and neighborhoods. For example, a scenario that is funded with equal amounts of bond and other tax revenues would be able to provide a \$10 broadband product to low-income homes in the city.

Probably even more intriguing is the idea of lowering the cost of broadband for everybody. For example, we looked at a scenario similar to what has been proposed in San Francisco. This scenario would provide \$50 gigabit product, a \$20 100 Mbps product, and a free low-speed broadband connection to anybody that wants it. This scenario requires significant tax funding and would be feasible with a \$43 M bond supported by the broadband business and \$89 M of other tax funding.

Open Access Looks Hard to Justify. It looks hard to justify an open-access network. This is a network that allows access to multiple ISPs and provides more options for customers. The operating losses for the scenario are much greater than if one ISP operates the network because it splits the potential revenue. This scenario could only be made to work with significant funding (\$80 M) or more from tax revenues.

MDU Penetration Rates Are Challenging to Forecast. The report looks in depth at the issues associated with providing broadband to multi-dwelling units (MDUs). There are a number of challenges that must be overcome to make sure that all MDUs have fast fiber broadband. First, it's the property owner's choice to allow connection to a city-owned fiber network. Many MDU owners will elect to connect instead to Comcast, AT&T, or other providers that specialize in serving MDUs. The cost to wire and distribute fiber in MDUs also varies significantly in MDUs depending upon a number of factors which are described in more detail on pages 37-39.

Timing of Network Launch. It should be reasonable to build a citywide fiber network within three years from the date of funding, with the first customers on the network after 18 months.

Recommended Next Steps

Residential Survey. Our analysis shows that the most important variable affecting the financial feasibility of building fiber is the potential number of customers. For example, getting 40% rather than 50% of residents on the network makes a big difference in expected future revenues.

We recommend that the city undertake a residential survey to understand interest in a fiber network. CCG Consulting has found that a well-designed random residential survey is a good predictor of the number of residential customers that might be interested in using city-provided fiber. We've been able to see a significant correlation when comparing the results of initial surveys to the actual customer penetration rates.

Since the study results show that some amount of tax financing is likely going to be needed to fund a fiber network such that it will be cash flow positive, it's vital to predict the percentage of households that might be interested in fiber. Knowing the range of possible customer penetration rates will allow the city to then better quantify the amount of tax revenues that are needed to fund each scenario.

MDU Analysis. The report looks in detail at the issues associated with providing service to MDUs. Since MDUs represent a big percentage of the living units in the city, understanding the potential for serving MDUs is needed to fully assess potential revenues of a fiber business. The city might want to undertake a deeper analysis of the MDU market. The more you know about that market the more you will be able to understand how a Davis-owned fiber network might benefit this market.

Ideally the city might want to know the following things about the larger MDUs in the city:

- Census of MDUs. Identify the owners, local managers, and decision makers at each MDU that might be involved in making the decision to connect to a city fiber network.
- Cost to Wire with Fiber. The report describes the many factors that are involved with distributing fast bandwidth within an apartment building or complex. The city might want to ask MDU owners of differently sized MDUs to allow the city (with the help of engineers) to make an on-site estimate of the cost to upgrade their MDU to fiber. This report looks at some theoretical costs to wire MDUs of various sizes and technologies, but we also discuss the various factors that can affect the specific costs of upgrades. If the city were able to examine MDUs of various sizes you would be able to better estimate the cost of providing fiber broadband to the MDUs.
- Survey of MDU Owner Interest / Penetration Rates. It would be useful to understand the broadband intentions of MDU owners. Ideally the city would like to know how many MDUs already are connected to fiber and the intentions or goals of those that are not connected. It might be difficult to collect this information since many MDU owners would not want their intentions to be discoverable through a public information request. But we know other cities that have gathered this information through an anonymous questionnaire that doesn't identify responses with specific MDU owners. But since MDUs represent such a significant percentage of the housing units in the city, an effort should be made to better estimate penetration rates.

Understanding the Funding Options. The analysis shows that financing costs are a major cost component for any of the fiber business models. It is essential for the city to understand its financing options in more detail. This might include steps like:

Assessing the Use of Revenue Bonds. Probably the predominant portion of funding would come from revenue bonds that are backed by city tax revenues. The city should talk to bond advisors to understand the possibility of using this kind of bonding as well to understand any nuances

Investigate the Possibility of Using Tax Revenues. The financial analysis shows that it will be necessary to finance at least some of the cost of building a network using tax revenues. Tax revenues could come from a variety of city cash flows such as sales taxes, property

taxes, or some sort of utility fee. If the city wants to proceed after this study then it's going to be necessary to understand the possibility of using tax revenues. There are a number of steps needed to understand the potential for this kind of funding. This might include:

- An analysis of the various types of such funding that might be available;
- A legal and financial analysis of any issues with using such financing to pay for a fiber network;
- Public outreach to understand the public's willingness to use these kinds of financing for fiber. This probably would entail a large public education campaign and probably eventually result in a ballot measure – so it's a major undertaking.
- Consideration of other City infrastructure needs.

Investigate Other Revenue Sources. The vast majority of a fiber network will have to be financed by the above two kinds of financing. But there are often opportunities to get some funding from other sources. For example, we've seen cities get transportation grants for smart traffic signals that can be used partially for fiber. We've seen public safety grants that were able to fund some fiber. We've seen homeland security grants that were able to fund some fiber. It's hard to know what might be available in Davis since these kinds of grants vary from year to year – but there might be grant opportunities if you are willing to explore all of the grants available. Such funding would not likely cover more than a few percent of the cost of the network, but even that would lower financing costs significantly.

Choose a Business Model. The business plan that looks to be the most promising from a financial perspective is for the city to build the network and to partner with a nonprofit or commercial entity to operate the triple-play business. There are two options for that operating model. One is to build only to customers that buy a product on the network. A second option to build to everybody also looks intriguing. A larger build would allow the city to tackle the digital divide and other social goals for the network.

But there are other possible operating models and the city should first narrow down the options. There are four basic business models to consider:

- The city becomes the ISP and hires staff and operates the business.
- The city hires an operating partner that operates the business on behalf of the city. This partner would be a vendor and all of the revenues of the city would belong to the city.
- The city builds the network and charge one or more ISPs to use the network (open access). There is one nuance of this model which would be to start with one partner to jump-start the business with the ultimate goal of having multiple ISPs in an open access environment. For example, this is how Huntsville, AL (Google Fiber) and Westminster, MD (Ting Broadband) have launched.
- Finally the city can partner with an ISP that is willing to make a significant investment into the network, a model that's referred to generically as a public private partnership.

One of the early next steps needs to be to have the policy discussions to pin down the potential operating model, hopefully to just one of the above options, but to no more than two. Each business model is unique and it would be difficult to explore all of them at the same time.

Identify Potential Partners.

If the city chooses an option other than the city acting as the ISP, then a natural next step is to talk to potential partners.

Some cities have engaged in this process by issuing an RFI or other similar document that asks potential partners to describe their interest. We don't like this approach because we know that many ISPs will not put their intentions into writing and thus many potential partners might not respond to an RFI. The alternative process is to open direct discussions with potential partners that you know. Another alternative is to mix the two processes—issue a short RFI that asks for potential partners to identify themselves but then leave the more detailed discussion to be done on a one-on-one basis with each respondent.

The steps needed to reach an agreement with a partner are fairly well defined in the industry. It would include such steps as:

- Identify the Specific Roles of Both Parties. There are a number of ways that a city can work with an operating partner. For example, it is possible for the city to operate the network and a partner to provide services to customers. However, a partner could also do everything including operating the fiber network. We've found that the best way to define roles is to create a detailed checklist of functions and responsibilities so that the two sides clearly understand their specific roles.
- Define the Financial Relationship. There are also multiple possible financial arrangements. We would expect, for instance, that the financial arrangements would be different for a nonprofit partner like Davis Gig versus a commercial partner. Financial arrangements can vary widely and might include management fees, profit sharing, or leasing the network to a partner.
- Define Operating Metrics. It is essential to establish the expectation for operating the business and this is usually defined through the use of metrics. There might be metrics to cover a range of operating parameters such as network performance, customer installation times, sales goals, customer service response times, etc.
- Negotiate an Operating Agreement. Once the roles, the financial relationship, and the operating metrics have been negotiated, the end result is generally some kind of operating agreement that encapsulates the relationship.

Community Education/Buy-in. If the city decides to continue with investigating the fiber business then a step that most cities take is to undertake a community education process to get feedback and gain buy-in of the concept.

Cities go about this in different ways. Making this report public is a good first step. Communities often hold workshops or other kinds of public presentations to answer the public's questions. It's common to build a web site that discusses the fiber initiative and which can be used to answer the typical questions citizens have about fiber.

Consider Implementation of Fiber Network in Phases. One of the ideas mentioned in the report is to look at undertaking the network in phases. For example, the city might want to consider first building fiber for the purpose of providing additional connections between city facilities. That idea

could be expanded further to build to better connect the city and the University. Another phase could be building fiber to a few key business districts such as University Research Park, Second Street research and development/light industrial area, Downtown and perhaps to some large MDU complexes.

It's worth noting that many of the existing municipal fiber networks were built in phases. For example, both the Chattanooga, TN and the Lafayette, LA network began with a fiber network to serve city locations, then expanded to serve key business districts and finally expanded to serve everybody. Also, while there are less than 150 cities that have built fiber to everybody, there are many hundreds of cities that have built networks to serve city facilities or to reach business districts – this is a common municipal fiber model. As part of looking at a phased approach the city might want to talk to cities of similar size that have undertaken the phased approach.

This study was intended to quantify the opportunity for building fiber everywhere. A separate study would be required to quantify the option to build something less than that. For example, if the goal was to look at a network that served larger business and MDUs on a wholesale basis, an analysis and design would need to be determined of the layout of the fiber network to accomplish that goal. This requires a bit deeper engineering analysis than was done in this high-level feasibility study. Such a study should also be done in conjunction with the next step identified above of better understanding the MDU market.

In-Depth Review of City Practices (that affect fiber). Like every city, there are practices and processes in the city that impact the initial cost of building a fiber network. This would include such things as permitting, franchise requirements, traffic control, construction inspection, etc. Cities often review all of these practices before tackling a fiber network to see if any practices can be streamlined.

Any changes in these practices would also impact existing telecom providers as well as a potential city fiber network, and so the city would want to invite the existing ISPs and incumbents into the discussion.

There are a number of ways to go about this. One approach is to hold workshops with affected stakeholders to get input. Another approach would be to instead get an external review by engineers or others who can compare the city's current practices with what's found in other cities. A third approach would be to find out what cities that have built fiber networks have done (or wish they had done after they went through the process of constructing the fiber network).

Keep an Eye on Broadband Prices. There is speculation in the industry and Wall Street that Comcast and the other big cable companies are going to significantly increase broadband prices over the next few years. The sensitivity analysis shows that prices are among the most important and sensitive variables in the business plan, and the projected financial performance would improve with higher prices. However, this also has to be tempered with a policy question of whether a city-owned network would charge a lot more than today just because Comcast does.

Our base analysis does not suppose any broadband price increases. But we looked at several scenarios that increase prices over time and found that higher prices can significantly improve the

cash flow of any of the operating models. But we caution strongly against building a business plan that requires significant price increases to succeed. While there is a general expectation that Comcast and other large ISPs are going to raise broadband prices over time, this does not mean that they would raise prices in a market where they are competing against a competitive fiber network. For example, we've seen big ISPs drop rates in markets where Google Fiber or other municipal fiber networks have been built and it's not a far-fetched scenario to think that the ISPs will suffer with lower rates in the handful of competitive markets and make up for it with higher prices everywhere else.



825C Merrimon Ave, Box 290
Asheville, NC 28804

Residential Broadband Survey Report

Davis, California

Survey Methodology

The survey was given to residents that live within the city boundaries of Davis today and was administered by CCG callers by telephone. We obtained the telephone numbers by purchasing a database of current phone numbers that is guaranteed to be a mix of both landline and cellular telephone numbers.

Most business and political surveys strive to achieve an accuracy of about 95% with results that are plus or minus 5%. In layman's terms this means that the results of such a survey are reliably accurate (the 95% number) and you would expect to get the same results (within 5%) if you could ask the questions to everybody in the survey universe.

At CCG we use an online survey tool that is provided by Creative Research Systems and is found online at <https://www.surveysystem.com/sscalc.htm>. We've used this tool for many years and I've manually done the mathematical calculations to demonstrate that the tool is accurate. In last year's feasibility study we determined that there are 16,528 single family homes and duplex units in the City and 10,226 apartment and condominium units. We completed 360 surveys for the City, and for the universe of living units in the City the online tool shows the accuracy of this survey to be 95% accurate plus or minus 5.13%.

One key aspect that help to make sure that the target accuracy is reliable is to make sure that the survey was conducted randomly. In this case we were able to start with a file that mingled cellular and landline telephone numbers. We then used a method of calling every 20th number in the listing. This method is called systematic sampling and is used by almost all companies that conduct phone surveys. With systematic sampling, we call each 20th number, and when we reach the end of the phone list we cycle back to the beginning and continued to select every 20th number until we obtain enough responses. We typically must call 6-7 residences for every completed survey (many don't answer and some refuse to take the survey), so we recycled through the number list multiple times.

Survey Results

Demographics

They survey was only given to those that live within the Davis city limits. Since our calling list did not include addresses we didn't know the location in the City of any given caller.

71% of the respondents live in single-family homes or duplexes. The remaining 29% live in apartments or condominiums. One might have expected, by looking at the number of living units that 38% of the responses should have come from apartments. I speculate that a lot of students and other more transient residents don't make it into the databases of phone numbers that we purchased, but this is just a guess.

The survey asked each respondent where they live in the City, using a description that divided the City into 5 geographic areas. We got a significant number of completed surveys from each of

the five neighborhoods – which alleviates the concern that the survey might not represent the whole City. The distribution of respondents was as follows:

North of Covell Blvd	59	16%
South of I-80	56	16%
West of 113	68	19%
East of north/south Union Pacific Railroad	93	26%
West of north/south Union Pacific Railroad	84	23%

We asked apartment residents about the size of their apartment complexes. 14% live in apartments with 10 units or smaller; 16% live in apartment complexes of 11 to 50 units; the remaining 70% live in apartment complexes of 50 units or larger. This tracked reasonably well with apartment demographics since 75% of all apartment units in the City are in complexes of greater than 50 units.

Current Broadband Utilization

The survey asked respondents about communications services that they buy today and asked them questions about how they like their service providers. We asked slightly different questions of single-family homes versus apartment dwellers because we already knew from the feasibility study that the two groups obtain broadband, cable TV and landline service in different ways.

The survey shows that 86% of those in single-family homes and duplexes have a landline broadband connection at home. This is almost identical to the nationwide average that was recently estimated by the FCC to be just over 85%. For those without a landline connection, roughly half use their cellphone as their only source of broadband, and an equal number have no broadband connection of any kind. One respondent said they used hotspots for broadband, which could be in coffee shops, the library or some other place with a public WiFi connection.

The broadband situation in apartments is far more complex than single-family homes since landlords provide different options for tenants. 98% of the respondents in apartments have a home broadband connection today. A lot of this is due to apartments that include a broadband connection in the rent. The survey shows that 42% of apartments get broadband as part of the rent. 13% of apartments can buy broadband but have only one provider available to them – this is a choice of the landlord who can restrict ISPs from serving in apartments. 43% of the respondents in apartments say that they have a choice of more than one ISP.

It was a bit surprising that only 2% of apartment residents don't have a broadband connection. This can partially be explained by the fact that 42% of apartment dwellers get broadband automatically as part of their rent. I can only speculate why almost all of the rest of the respondents buy broadband. It might be related to the fact that many apartment dwellers are students or are younger on average than those living in single-family homes – but we don't know why this is so.

Satisfaction with Internet Service Providers (ISPs)

We asked residents living in single-family homes and duplexes how they feel about their ISP provider. We asked respondents to rate ISPs in terms of quality of customer service, reliability, and the cost value of their broadband product. The results are somewhat surprising in that households are not unhappy with their ISPs. We did not ask these questions to those living in apartments since we already know that the landlords are the ISP in many instances.

Only 16% of households were dissatisfied or very dissatisfied with ISP customer service. Only 11% of households were dissatisfied or very dissatisfied with the reliability of their broadband connection. A larger 23% were dissatisfied or very dissatisfied with the cost value of their broadband product, indicating that there is more unhappiness with price than with the other aspects of ISP service.

Finally, we asked respondents if they are happy with Internet speeds at home. 37% of those in single-family homes and 35% of those in apartments said they were not happy. We asked for the reasons for dissatisfaction and got the following responses:

- Broadband is lagging. We have seen this response across the country and have always interpreted to mean that people feel like they are waiting on their broadband connection to respond to a request. This could be related to broadband speeds, but it also could be related to other issues that make a broadband connection feel slow. The two most common problems of this kind are poor latency and high jitter.

Latency measures delays in the broadband signal. Latency depends to some degree on the technology being used. For instance, fiber connections have far less latency than a cable modem connection, and a cable modem connection has less latency than a telephone copper DSL connection. Latency can also be caused by problems within the home network such as an out-of-date or obsolete WiFi router. Finally, poor latency can be caused by networks that are too busy – a phenomenon that most people understand by seeing how a network feels slower at the peak times in the evening when everybody in the neighborhood is trying to use broadband at the same time.

Jitter is the same as network noise or interference. Most technologies have very little jitter if the network is functioning perfectly. However, network often have problems such as electronics that are not working perfectly. Again, the home WiFi router might be inadequate. And sometimes there is literal interference – for instance, outside radiation sources like a microwave oven or some other radio source can interfere with signals on both telephone and cable networks.

- Can't watch video streaming. This is a particularly interesting response. It doesn't take a lot of bandwidth to watch streaming video. For example, the typical SD (standard definition) Netflix stream uses roughly 1 Mbps of bandwidth. High definition video streaming can use between 4 Mbps and 7 Mbps depending upon the compression technology used and the amount of action within the video stream. Most broadband connection in the City ought to be able to handle a video stream, yet in the last few years we began seeing this complaint on most surveys we've done.

Interestingly, when we conducted similar surveys in the past, we rarely heard this complaint. I'm speculating, but my guess is that many homes are now expecting to conduct multiple tasks at the same time, and it is the interference from multiple demands on bandwidth that are causing this to be an issue now, when it wasn't in the past. However, an alternate explanation could be that there has been some change in the streaming technology that makes a stream more sensitive to interference and noise – but I've not heard any technologists making such a claim. It's also likely that we are hearing this complaint more today due to the fact that 60% or more of homes now watch streaming videos.

- Can't Work. We are hearing this complaint a lot more than in the past and believe that it's indicative that more employers are willing to let employees work from home, even if only occasionally.
- Have to reboot; connection freezes up. These complaints are highly indicative of poor performance within the ISP networks. In looking through the responses these kinds of complaints came from both AT&T and Comcast customers.

The survey asked if respondents know the speeds they are supposed to be receiving – that is, the marketing speed promised by the ISP. 65% of those in single family homes did not know their promised speed. We would not that this is not unusual and the analysis we did of customer bills during the feasibility study showed that very few broadband bills remind customers of their speed. We saw that 92% of those in apartments didn't know their speed, which probably is driven higher by the fact that many of them get broadband from their landlord.

Cable TV

In perhaps the most surprising finding in the survey, 91% of those in single-family homes said that they subscribe to a traditional cable TV provider. 45% of the market uses Comcast, 20% uses AT&T and 26% have a satellite provider. This is much higher than the national average that is currently estimated by industry analysts to be around 69% of households and is dropping currently by 2% of the market per year. The percentage of cable subscriptions was even higher in apartments at 99%, but that is probably boosted by the fact that cable is included in the rent for 40% of these respondents. Where residents had a choice of provider most selected Comcast.

Both of those numbers are astounding in that they are so far higher than the national average. Since the survey was conducted randomly throughout the City one has to believe the results. It's highly unlikely statistically that we only called homes that happen to have cable TV – the whole point of a random sample is to eliminate that kind of aberration.

Landline Telephone

The survey showed that 64% of respondents in single-family homes still have a landline. Of those, 37% use AT&T, 26% use Comcast and 1% used a voice over IP provider.

For those living in apartments, 53% have landlines, but that includes 15% of respondents who said a landline is included in their rent.

The nationwide average penetration for landlines is roughly 45%. The landline penetration rate for single family homes is higher than average while for apartments it's close to average after accounting for those that get a phone in the rent.

This is the one response in the survey that might be biased. We purchased a list of phone numbers and have no way of knowing the proportion of landline and cellular numbers on that list. In fact, this can't be known by the companies compiling these lists because after a few decades of number portability you can't tell by the phone number if it's for a landline or cellular phone. Anecdotally my cellphone number that I've had for 22 years was once my landline number. However, there is the possibility that the calling database included more landline numbers than represented by the whole universe of numbers in the City. This is something we can't know, but it does cause me to apply caution in trusting this result. With that said, the percentage of landlines in apartments is fairly close to the national average, so perhaps the survey numbers are correct.

Bundles and Pricing

We asked about the manner in which people buy telecom service – in bundles or individually and also how much they pay. We must report before discussing the results to disclose that over the years we've found that people often don't know what they actually pay, so this question really measure what they think they pay.

The survey shows that 82% of those in single-family homes buy some kind of bundle – that's 55% who buy a triple-play bundle, 22% who buy a bundle of cable TV and Internet access, and 5% who buy some other kind of bundle, such as a combination of telephone and Internet access. The big ISPs don't report the number of customers buying bundles, so we don't know the nationwide average. For the many surveys we've done I'd guess that the average we see has been around 75%, but we've seen markets significantly higher and lower than that average.

The results for apartment residents are a little harder to interpret since residents of different apartment complexes have different options. For example, 37% of those in apartments say they buy the triple play with another 22% claiming to buy the double play of cable TV and broadband. On the surface that result doesn't look right since 42% of apartment residents say that broadband is included in the rent and 40% say that cable TV is included. However, a significant number of apartment tenants are able to pay more for an upgraded product – either faster Internet or more cable TV channels, and it's likely that some of the bundles are for these upgrades.

The survey shows high monthly bills for a lot of households. For example, for single-family homes only 7% have a triple play for less than \$100 per month while 49% pay more than \$150 per month. Even the bundle without landline telephone is expensive with 47% of those choosing that bundle paying more than \$100 per month. For households buying only Internet access, 48% are paying more than \$75 per month.

The prices are lower for those in apartments – something you would expect since some products are included in rent. However, even 25% of those living in apartments are spending more than \$150 per month for a triple-play bundle. We could see the impact of having basic products as

part of rent since the few apartment residents buying cable TV or Internet access alone are paying rates far below the rest of the market – meaning that these are likely upgrades to products included in the rent. For example, one respondent says they are paying \$5.99 for broadband and two respondents say they are spending \$20 for cable TV.

A New Fiber Network

We asked a series of questions to see how residents feel about the possibility of bringing a new fiber optic network to the City.

We asked if respondents were in favor of the City building a fiber optic network. 69% of those in single-family homes are in favor of a fiber optic network. Another 2% said they might be in favor, with another 8% offered a qualified ‘maybe’ saying that it depends on the price of services. Apartment residents were more enthusiastic about a fiber network with 88% in favor with 4% who said they might be in favor. Overall the composite response was 74% in favor of the City building a fiber optic network.

We asked if respondents had a preference on who would operate a new network and got mixed results. 39% were in favor of the City operating the network, 36% were in favor of having somebody else operate the network and 21% had no preference. This indicates to me that if you build the network that you ought to have an educational campaign to defend whatever choice you make about the operator.

We asked respondents to tell us what might influence them to move their service to a new network. Respondents were allowed to choose more than one response. 78% said they could be lured to a new network by lower prices than they pay today. 62% said they would be influenced by faster speeds for the same price they pay today. 43% said they would be influenced by getting better customer service.

We have always seen a strong positive response in every survey we’ve ever done in response to the question about lower prices. What that response doesn’t tell us, however, is how low prices might have to go to attract customers. The response for wanting better customer service is a bit surprising since so few people said they were dissatisfied with the customer service of their service provider.

In what is probably the key response in the survey, we asked respondents if they would buy Internet service from a high-speed network owned by the City. The responses were different for single-family homes and apartments.

For respondents in single-family homes, only 21% said they would definitely buy from a City network. Another 31% said they would probably buy and 30% said they might buy. At the other end of the scale, 10% said they would definitely not buy and 8% said they would probably not buy. It’s worth noting that most of the single-family homes without broadband today are included in one of the negative responses.

There are several ways to interpret this result. The rosier interpretation is that almost everybody that has a broadband connection today would at least consider using the new network (those that said yes, probably or maybe). However, the 21% who said ‘definitely yes’ is smaller than what we normally see in markets that are enthusiastic about fiber. For example, we recently completed several surveys for cities about half the size of Davis that each had more than 50% of households saying they would buy service from a new fiber network.

As we reported in the feasibility study, we usually find that somewhere between 20% and 30% of the residents of almost every market will jump to a new network provider out of dislike for the incumbent providers. We would expect to see such households comprise most of the ‘definitely yes’ category - but we’d had anticipated a higher response for other reasons, such as being excited about getting onto fiber.

The distinction between yes, probably and maybe is important. In our experience you’d expect those that said ‘definitely yes’ to change to the new network. The ‘probably’ category can be convinced to change, but that will require some significant marketing and sales effort. Those saying ‘maybe’ are on the fence and will require a prolonged multi-year marketing effort to capture as customers. Within that ‘maybe’ category is a block of customers who will bounce between providers to get the latest special pricing promotion.

In a City with a high enthusiasm about fiber we’d expect to see more people saying ‘definitely yes’ than ‘maybe’. Probably the most pessimistic reading of the results is that customers are willing to consider a fiber network, but a significant marketing effort will be required to get many households to try the network.

The results for those living in apartments are also interesting. 32% said they would definitely change, 38% said they would probably change and 27% said they might change. Nobody said they would not change. However, we have to interpret these results by remembering that 42% of apartment residents already have broadband included in their rent, meaning that many of them might not see the option of using a City fiber network even was it built.

It’s interesting that those in apartments are more enthusiastic about fiber than those in single-family homes. I might speculate that part of the difference might be that apartment tenants are likely younger than those living in single-family homes – but we don’t know why they have a more positive response to a potential fiber network.

Finally, we asked each respondent to rank four aspects of broadband in order of importance: price, speed, data privacy and customer service. 58% said that price is the most important factor; 27% said speed is the most important; 10% said privacy is the most important and 7% said that customer service is the most important.

Summary

The most important take-aways from the survey are as follows:

- I think many in Davis might be surprised to find out that AT&T has nearly the same broadband penetration in single-family homes as Comcast. We normally see a much

wider gulf between the incumbent cable provider and telco. Comcast just recently increased broadband speeds for all of their customers, supposedly to 200 Mbps as the base broadband product, and perhaps over time this will increase their market share. The AT&T DSL is already delivering the fastest speeds possible without a major upgrade.

- The survey shows a higher cable TV penetration rate than the national average, although we have seen a few other markets with penetration rates this high. For some reason this indicates that there are not yet as many cord-cutters in Davis as in many other markets in the US. I've not seen any research that has looked at regional differences in cord cutting.
- The most important result of the survey is that only 21% of homes said they would definitely buy broadband from a new City fiber network. This is significantly lower than what we've seen in many other markets. However, only 18% said that they would not consider moving to a fiber network, meaning that most of the households in the market who have broadband today would at least consider moving to a fiber network. If I was asked to characterize this response I'd say that this indicates a market that is not massively unhappy with the incumbent providers and not wildly enthusiastic about fiber. It's a market where a new provider would need to prove themselves and expend significant marketing effort to win over customers.

DAVIS Residential Survey

Location

1. Do you live in:

Single/Family Home / Duplex	257	71%
Apartment / Condominium	103	29%

2. Where do you live in Davis?

<u>Single Family Home / Duplex</u>		
North of Covell Blvd	43	17%
South of I-80	36	14%
West of 113	43	17%
East of north/south Union Pacific Railroad	67	26%
West of north/south Union Pacific Railroad	68	26%

<u>Apartment / Condominium</u>		
North of Covell Blvd	16	16%
South of I-80	20	19%
West of 113	25	24%
East of north/south Union Pacific Railroad	26	25%
West of north/south Union Pacific Railroad	16	16%

Single Family Home / Duplex

3. If you buy Internet access at home, who is your provider?

Comcast	113	44%
AT&T	109	42%
Only use Cellphone data	17	7%
Other - Hot spot	1	<1%
Don't have Internet	17	7%

4. Using a scale from 1 to 5, where 1 is 'very dissatisfied' and 5 is 'very satisfied' please rate your Internet Service Provider on the following:

Customer Service	1	10	4%
	2	29	12%
	3	95	40%
	4	78	32%
	5	28	12%
Reliability	1	7	3%
	2	20	8%
	3	99	41%
	4	70	29%
	5	44	19%

Cost Value	1	8	3%
	2	49	20%
	3	132	55%
	4	35	15%
	5	16	7%

5. Are you happy with the Internet speeds you have today at your home today?

Yes	151	63%
No	89	37%

If the answer is no, what problems are you experiencing that are caused by slow speeds?

Lagging; can't watch videos / stream; can't work; have to reboot modem; freezes up.

6. Do you know the Internet speed the company says they are providing?

Don't Know	157	65%
20 – 25 Mbps	10	4%
26 – 50 Mbps	22	9%
51 – 100 Mbps	11	6%
101 – 150 Mbps	27	11%
Over 150 Mbps	13	5%

7. If you buy cable TV, who is the provider?

Comcast	115	45%
AT&T U-verse	52	20%
Satellite (Dish or DirecTV)	66	26%
Don't have Cable TV	24	9%

8. If you buy landline telephone, who is the provider?

Comcast	68	26%
AT&T	94	37%
Vonage or other VoIP provider	3	1%
Don't have a landline telephone	92	36%

9. Describe the way you buy these products:
(Percentages calculated using total households)

Bundle of cable TV, telephone and Internet access	143	55%
Bundle of Cable and Internet access	57	22%
Internet Access only	25	10%
Cable TV only	27	10%
Landline telephone only	30	12%
Other bundle (phone/internet)	13	5%

10. Do you know the amount of your monthly bill for:

Bundle of cable TV, telephone and Internet access

\$90 - \$100	10	7%
\$101 - \$125	22	15%
\$126 - \$149	41	29%
\$150 - \$174	34	24%
\$175 - \$200	22	15%
over \$200	14	10%

Bundle of Cable and Internet access

\$55 - \$75	10	18%
\$76 - \$100	20	35%
\$101 - \$125	7	12%
\$150 - \$174	5	9%
\$175 - \$200	15	26%

Internet Access only

\$30 - \$50	6	24%
\$51 - \$75	7	28%
\$76 - \$100	12	48%

Cable TV only

\$70 - \$99	18	67%
\$100 - \$110	9	33%

Landline telephone only

\$23 - \$39	8	27%
\$40 - \$50	22	73%

Other bundle

Internet/Phone

\$49 - \$60	4	31%
\$65 - \$112	9	69%

Apartment / Condominium

11. Can you describe the size of your apartment complex?

Small – 10 Units or less	14	14%
Medium – 11 to 50 Units	17	16%
Large – More than 50 units	72	70%

12. What are your options for buying Internet access?

Included in my rent and I have no other option	17	16%
Included in my rent but I have the option to buy faster speeds	27	26%
I can buy directly from one service provider only and that provider is		
AT&T	2	2%
Comcast	10	10%
Instaconnect	1	1%
I have the option to buy directly from several service providers and I use		
AT&T	7	7%
Comcast	37	36%
Don't have broadband	2	2%

13. What are your options for buying cable TV service?

Included in my rent and I have no other option	17	16%
Included in my rent but I have the option to buy larger packages	25	24%
I can buy directly from one service provider only, and that provider is:		
AT&T	2	2%
Comcast	10	10%
I have the option to buy directly from several service providers and I use		
AT&T	6	6%
Comcast	39	38%
Direct TV	1	1%
Don't know	2	2%
Don't have cable TV	1	1%

14. What are your options for landline telephone service?

Included in my rent and I have no other option	5	4%
Included in my rent but I have the option to buy larger packages	11	11%
I can buy directly from one service provider only, and that provider is:		
AT&T	1	1%
Comcast	4	4%
I have the option to buy directly from several service providers and I use		
AT&T	4	4%
Comcast	29	28%
Don't know	1	1%
Don't have landline telephone	48	47%

15. Are you happy with the Internet speeds you have today in your apartment / condo?

Yes	67	65%
No	36	35%

If the answer is no, what problems are slow speeds causing you today?
 Spotty coverage; download speeds are slow; can't stream.

16. Do you know the Internet download speed you are supposed to be getting?

Don't Know	95	92%
20 – 25 Mbps	2	2%
50 Mbps	2	2%
100 Mbps	2	2%
150 Mbps	1	1%
200+ Mbps	1	1%

Do you know your actual download speed?

Don't Know	101	98%
100 Mbps	1	1%
150 Mbps	1	1%

17. How much do you pay monthly for any services that are not included in your rent?

Bundle of cable TV, telephone and Internet access		
\$90 - \$100	4	11%
\$101 - \$125	8	21%
\$126 - \$149	13	34%
\$150 - \$174	8	21%
\$175 - \$200	5	13%

Bundle of Cable and Internet access		
\$55 - \$75	1	4%
\$76 - \$100	13	57%
\$101 - \$125	9	39%

Internet Access only		
\$ 5.99	1	25%
\$11.00	1	25%
\$15.00	1	25%
\$29.99	1	25%

Cable TV only		
\$20	2	50%
\$35	1	25%
\$50	1	25%

Landline telephone only		
\$75 - \$100	8	100%

Fiber Broadband

18. Would you be in favor of the City building a fiber optic network that could offer fast Internet access with competitive pricing to every home and business in the City?

<u>Single Family Home / Duplex</u>		
Yes	178	69%
No	41	16%
Maybe	4	2%
Depends on Cost	20	8%
Needs More Information	1	<1%
Don't Know	13	5%
 <u>Apartment / Condominium</u>		
Yes	91	88%
No	5	5%
Maybe	4	4%
Depends on Cost	0	0%
Needs More Information	1	1%
Don't Know	2	2%
 <u>Total Survey</u>		
Yes	269	74%
No	46	13%
Maybe	8	2%
Depends on Cost	20	6%
Needs More Information	2	1%
Don't Know	15	4%

19. If the City built a high-speed network, what is your preference on how it is operated?

The City operates	142	39%
The City has an operational partner	130	36%
No preference	76	21%
More information needed	6	2%
Don't support it	6	2%

20. What might influence you to move your current Internet service to a high-speed network owned by the City? (Can choose more than one)

Faster speeds for the same price	222	62%
Lower price than I pay today	282	78%
Same price as today but better service	156	43%
It matters to me who the new provider is	4	1%
Fiber doesn't make a difference to me	35	10%

21. Do you think you would buy Internet service from a high-speed network owned by the City?

<u>Single-family Homes and Duplexes</u>		
Yes, definitely	55	21%
Probably	79	31%
Maybe	77	30%
Probably Not	21	8%
Definitely not	25	10%
<u>Apartments and Condominiums</u>		
Yes, definitely	33	32%
Probably	39	38%
Maybe	28	27%
Probably Not	3	3%
Definitely not	0	0%
<u>Total</u>		
Yes, definitely	88	24%
Probably	118	33%
Maybe	105	29%
Probably Not	24	7%
Definitely not	25	7%

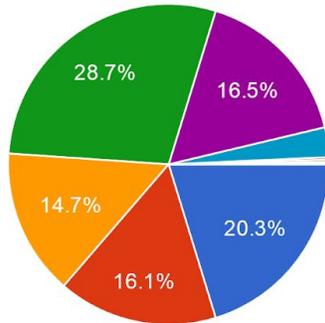
22.. Which of the most important factor in choosing an Internet Service Provider?
Rank from 1 to 4 with 1 being the most important (rank each item)

Price		
1	207	58%
2	113	31%
3	28	8%
4	12	3%
Speed		
1	98	27%
2	166	46%
3	69	19%
4	27	8%
Data privacy		
1	34	10%
2	52	14%
3	162	45%
4	112	31%
Customer service		
1	25	7%
2	28	8%
3	99	27%
4	208	58%

http://www.dcn.davis.ca.us/~help/DavisGIG_Broadband_Survey.pdf

Where Do You Live in Davis?

834 responses

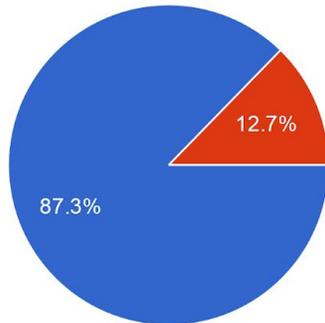


- Central Davis and Downtown Core
- West Davis - West of 113
- South Davis - South of 80
- East Davis - East of Railroad
- North Davis - North of Covell East...
- Periphery Community (e.g. NDM, E...)
- East of Railroad
- Downtown Core

▲ 1/2 ▼

What Type of Residence do you Live In?

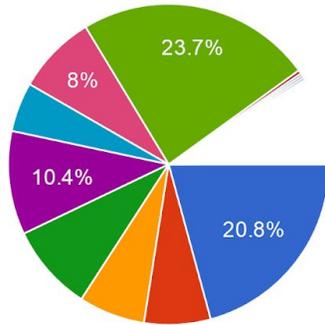
834 responses



- Single Family Home
- Apartment

What Type of Occupation?

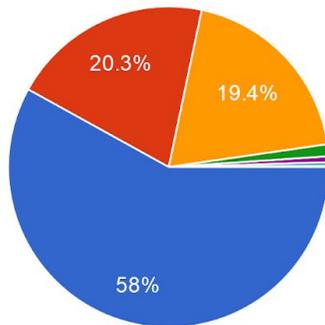
823 responses



- UCD Staff or Faculty
 - UCD Student
 - State Government
 - Home Based Business
 - Small Business (less than 50 employees)
 - Medium Business (50-500 employees)
 - Enterprise (500+ employees)
 - Retired
- ▲ 1/11 ▼

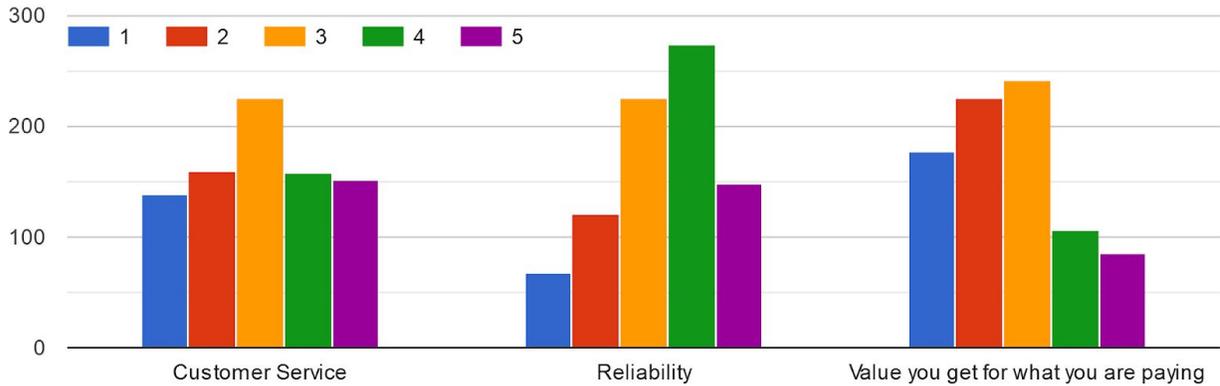
Who is your current provider of Internet Access?

834 responses



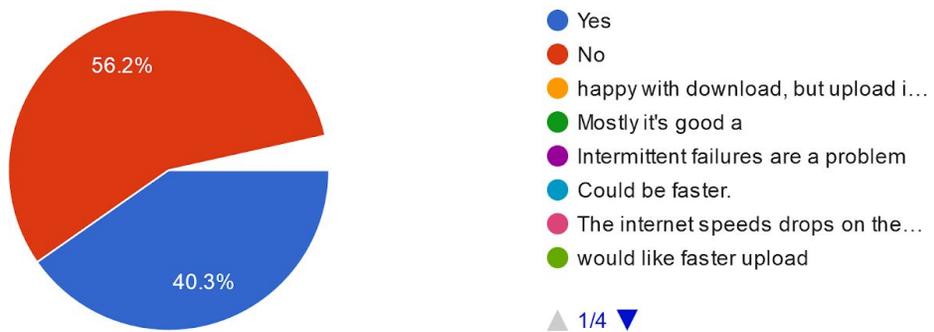
- Comcast or Xfinity
- ATT Broadband either Uverse or DSL
- Small ISP (e.g. Omsoft, Sonic.Net, Cal.Net, Instaconnect)
- Cell Phone Data (Verizon, T-Mobile, ATT, Sprint, MetroPCS)
- No Home Internet
- Omsoft
- Wi-fi included in rent and I have no idea what ISP the apartment manager...

Using a scale from 1 to 5, where one is 'very dissatisfied' and 5 is 'very satisfied', please rate your Internet Service Provider on the following



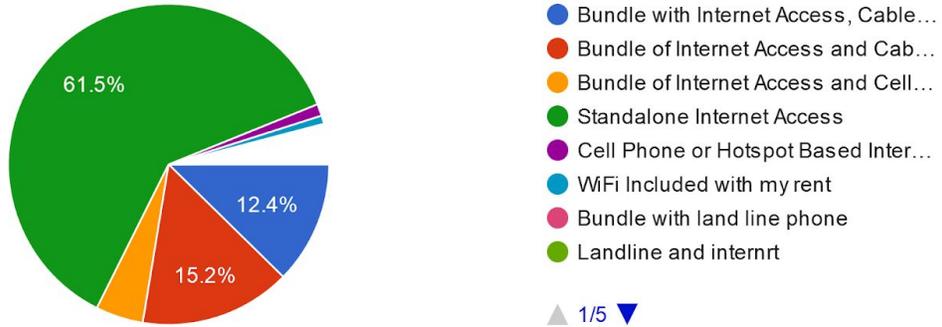
Are you happy with the Internet speeds you have today at your home?

834 responses

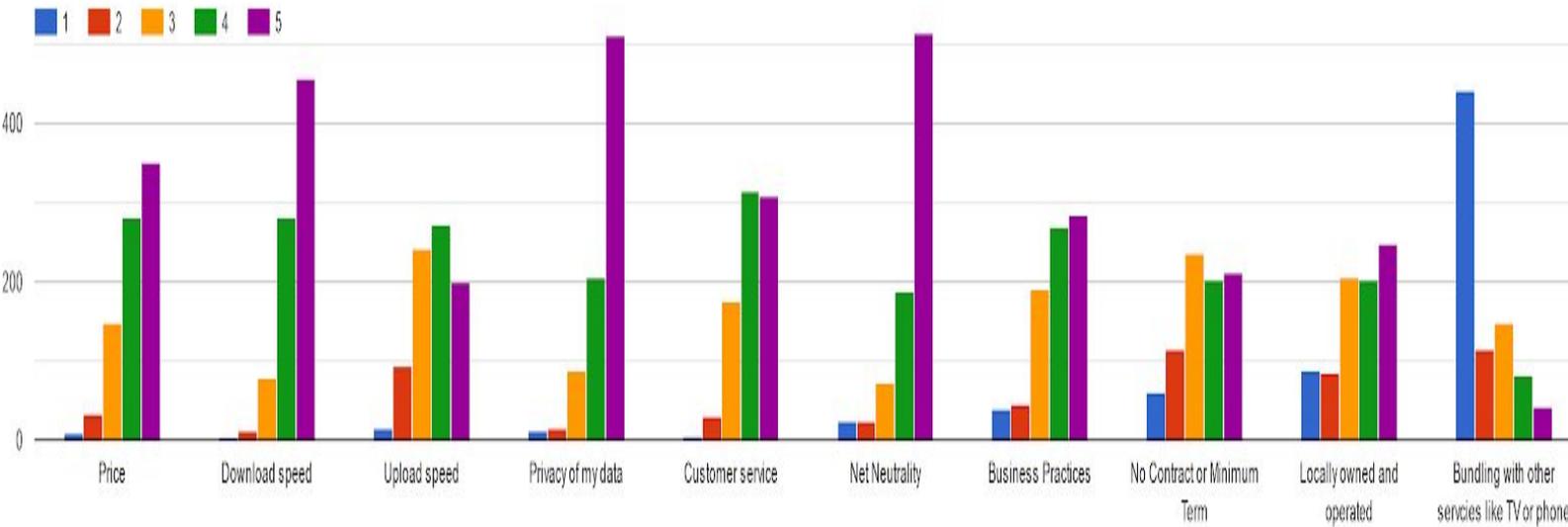


How do You Purchase Internet Access?

834 responses



Using a scale from 1 to 5, where one is 'Not Important' and 5 is 'The Most important', which of the most important factor in choosing an Internet Service Provider?

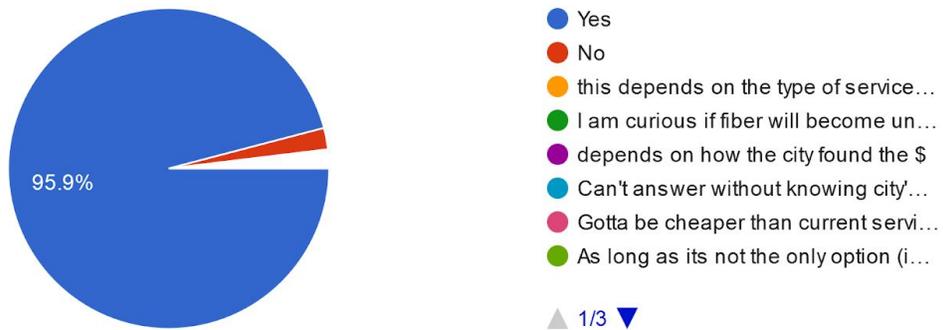


Community Owned and Operated Broadband

Assuming the City could find a way to pay for it, would you be in favor of the City building a fiber optic network that could offer fast Internet Access to every home and business in the City?

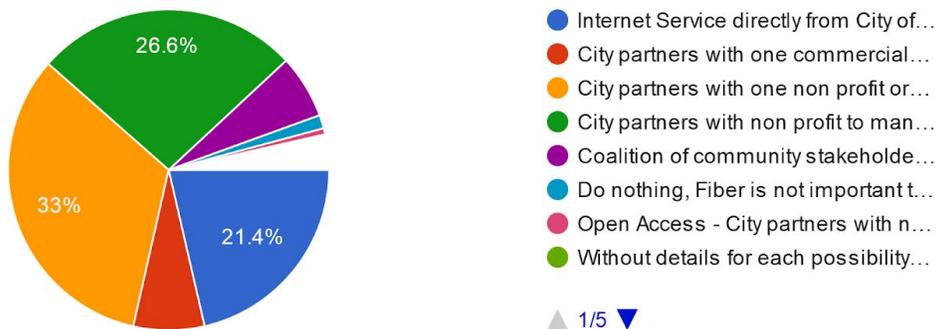
Assuming the City could find a way to pay for it, would you be in favor of the City building a fiber optic network tha...o every home and business in the City?

834 responses



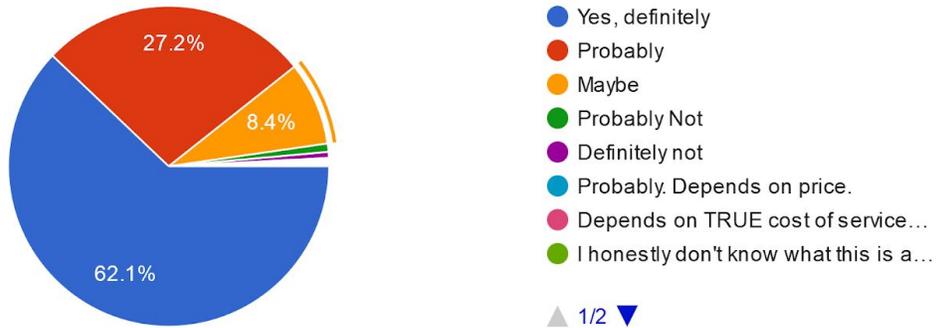
If the City built a fiber optic network, what is your preference on how it is operated?

813 responses



Do you think you would buy Internet Access or use other services offered from a community owned fiber optic network ?

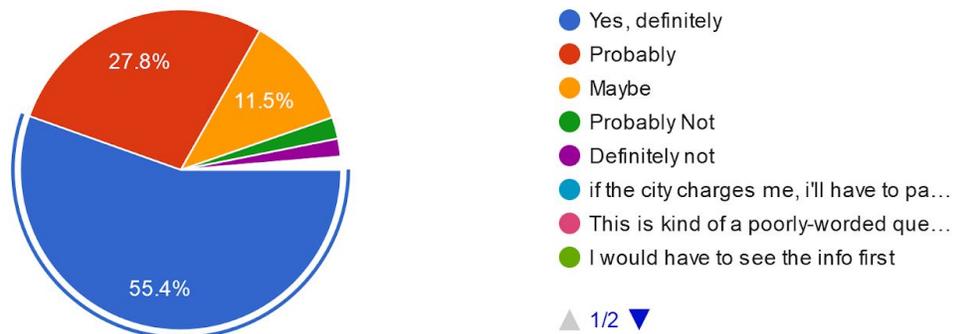
834 responses



Would you make the investment in community owned fiber optic broadband? Either by pay a monthly utility charge on your City utility bill between \$15- \$20, or some limited time parcel tax, or other reasonably priced finance mechanism to have the fiber infrastructure available for data, TV, phone services, and other future uses?

Would you make the investment in community owned fiber optic broadband? Either by pay a monthly ut...hone services, and other future uses?

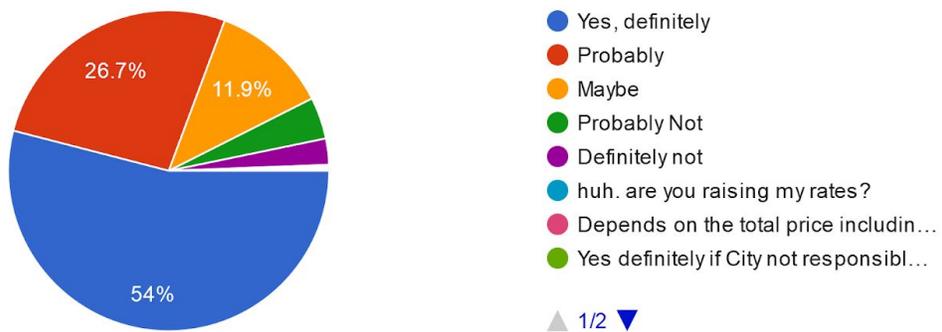
828 responses



Would you be willing to pay an extra \$5 or less each month on your broadband bill to fund a community non profit to manage the fiber network and ensure that all households, regardless of income level, would have access to a basic Internet Connection, and so that Fiber Internet access could be provided to every school student in the City?

Would you be willing to pay an extra \$5 or less each month on your broadband bill to fund a community non ... to every school student in the City?

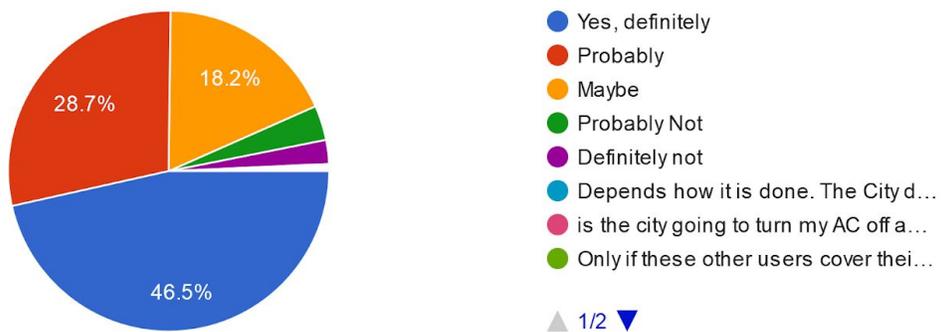
833 responses



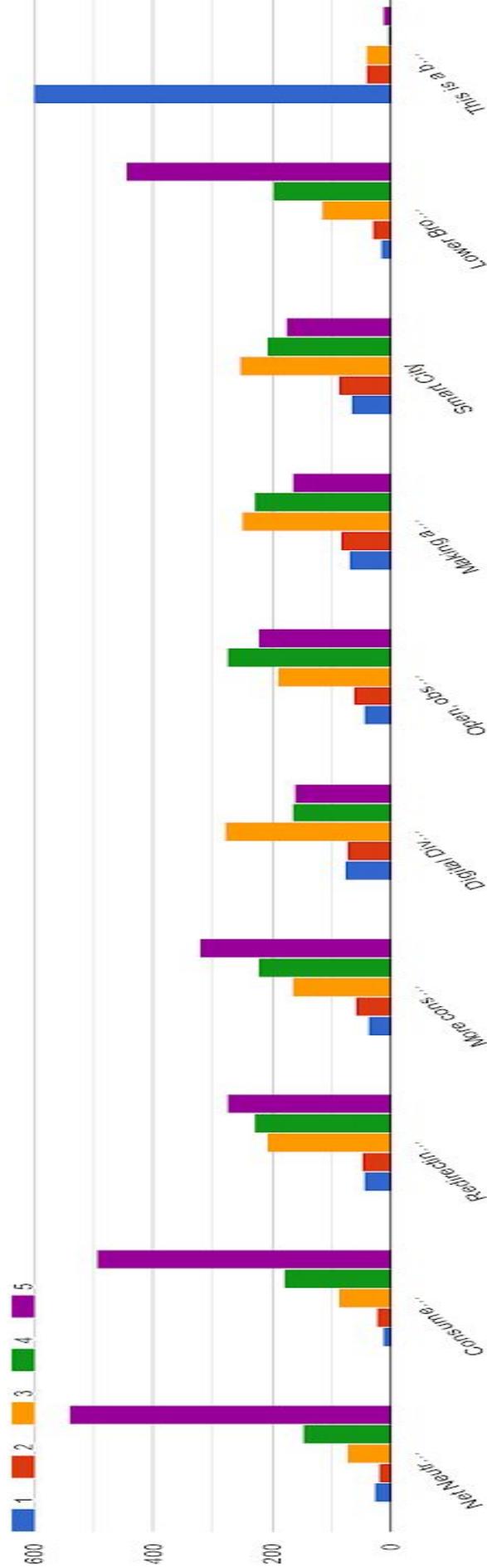
Are you in favor of using a community owned fiber network to develop "Smart City" type applications in Davis? Using Information and communications technologies for sensors to manage water, energy, traffic etc.

Are you in favor of using a community owned fiber network to develop "Smart City" type applications in Davis...rs to manage water, energy, traffic etc.

830 responses



Using a scale from 1 to 5, where one is 'Not Important' and 5 is 'The Most important', please indicate what you like about community-owned Fiber Optic.



From Left to Right the Categories are

- 1) Net Neutrality
- 2) Consumer Privacy
- 3) Redirecting Monthly Broadband Revenue to the City
- 4) More Consumer Choice, More Internet Products
- 5) Digital Divide
- 10) This is a bad idea, don't do this. Status Quo is fine.
- 6) Open, Observable, Participatory Network Ops
- 7) Making a network available to entrepreneurs to create new products and services
- 8) Smart City
- 9) Lower Broadband Bills because competition

Appendix IV: Map of the Study Areas Showing the Proposed Network Design and Fiber Ring

Davis, CA Broadband Study

