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Community Inspired Solutions

How Much Broadband Speed Do You Need?

Policy Brief – David Espinoza

The expansion of broadband connectivity is essential for both economic recovery and building an inclusive Sacramento region.

This Policy Brief ties together different aspects of internet use from household needs (i.e. speed, usage, multiple users' needs, and technologies), to larger regional deployment and cost analysis (i.e. broadband coverage by technology and cost to bring internet to unserved households).

How much residential internet service speed do you need? How much does it cost?

Having good internet service at home has been a growing need for California residents for more than two decades. Before COVID-19, if people did not have internet service at home, they could still find ways to access the internet by going to libraries, fast-food restaurants, or public Wi-Fi hotspots. After the shelter-at-home order, most areas of our lives have to be conducted from home, including working, attending classes, healthcare appointments, carrying out purchases, and accessing other online services -- on top of traditional entertainment usage of the internet. Therefore, if you do not have access to high-speed and reliable internet service at home, an important aspect of your life is missing.

If you need to set-up a video conference with a teacher, professor, primary care physician, co-worker, client, supplier, or a family or friend, having high-speed internet service allows consistent and reliable high-definition video and sound. Internet service at slow speeds may result in blurry and frozen images and choppy sound. The same service degradation occurs with other interactive online applications. The lack of or slow internet service means you are unable to take advantage of video conference capabilities or any other online services.

How much internet service speed do I need to be on a video conference?

The table below, from the Federal Communications Commission's (FCC) ***Broadband Speed Guide***, provides information on this topic. The General Usage category shows that Student and Telecommuting (teleworking) usage requires download speeds (in Megabits per second) from 5 Mbps to 25 Mbps. Video Conferencing requires speeds from 1 Mbps to 6 Mbps. Arguably, based on our internet user experience, higher speeds are needed. The guide itself states *"These numbers are rough guidelines and are not based on surveys or experiments conducted by the FCC. You should use your best judgment when choosing your broadband service."* Therefore, you should subscribe to higher speeds, based on an estimate of what you actually need, especially if your internet service does not reach the maximum advertised or contracted speed. You can assess your actual speed by running an internet speed test (e.g., **CalSPEED app**), and comparing the results against your contracted speed. If you are a student or telecommuting, you might need to purchase a plan higher than 25Mbps. Other useful parameters to evaluate a good internet service experience are upload speed, latency, jitter, packet loss, and reliability (uptime). For video conference usage, you might need upload speeds comparable to download speeds (from 1Mbps to 6Mbps). Regarding other parameters (jitter, latency and packet loss), smaller is better; while for reliability, higher is better.

Activity	Minimum Download Speed (Mbps)
General Usage	
General Browsing and Email	1
Streaming Online Radio	Less than 0.5
VoIP Calls	Less than 0.5
Student	5 - 25
Telecommuting	5 - 25
File Downloading	10

Social Media	1
Watching Video	
Streaming Standard Definition Video	3 - 4
Streaming High Definition (HD) Video	5 - 8
Streaming Ultra HD 4K Video	25
Video Conferencing	
Standard Personal Video Call (e.g., Skype)	1
HD Personal Video Call (e.g., Skype)	1.5
HD Video Teleconferencing	6
Gaming	
Game Console Connecting to the Internet	3
Online Multiplayer	4

What if I have multiple simultaneous internet users at home?

Multiple simultaneous internet users at home has been the case in most households during the shelter-at-home order. The table below, from the ***FCC's Household Broadband Guide***, shows that a household with one student in K-12 requires from medium (12 to 25Mbps) to advanced (more than 25Mbps) service. If there are more than three internet users at home, advanced internet service is required.

	Light Use	**Moderate Use**	**High Use**
	(Basic functions: email, browsing, basic video, VoIP, Internet radio)	(Basic functions plus *one* high-demand application: streaming HD video, multiparty video conferencing, online gaming, telecommuting)	(Basic functions plus *more than one* high-demand application running at the same time)
1 user on 1 device	Basic	Basic	Medium
2 devices at a time	Basic	Medium	Medium/Advanced
3 devices at a time	Medium	Medium	Advanced
4 devices at a time	Medium	Advanced	Advanced

Basic Service = 3 to 8 Mbps
Medium Service = 12 to 25 Mbps
Advanced Service = More than 25 Mbps

How do I get these speeds? Which technologies provide these speeds?

The following table shows maximum (theoretical) download and upload speeds for widely deployed broadband internet technologies. The technologies are grouped in three main categories: wireline (copper, cable or fiber optic lines), fixed wireless, and mobile broadband. The actual performance of these technologies varies depending on the actual deployment. For example, aging copper telephone networks might provide slower DSL service, oversubscribed cable networks might perform slower speeds, and fixed wireless and mobile broadband technologies might experience signal and speed degradation if there are obstructions between the tower and receiver antenna (in the roof or mobile device). It's important to note that fixed wireless service is different than mobile broadband service in technical, user application and regulatory aspects.

Technology	Maximum Theoretical User Download/Upload Speeds (Mbps)
Wireline	
ADSL2/ADSL2+ (12,000 feet loop)	6/1 Mbps
VDSL2 (3,000 feet loop) VDSL2 (5,000 feet loop)	35/6 Mbps 20/4Mbps
Cable Modem DOCSIS 2.0 Cable Modem DOCSIS 3.0 Cable Modem DOCSIS 3.1 Cable Modem DOCSIS 4.0	40/30Mbps 1Gbps/200Mbps 10/2Gbps 10/6Gbps
Fiber Optics 10GPON Fiber Optics 10G-EPON Fiber Optics Ethernet	10/10Gbps 10/10Gbps
Fixed Wireless*	
Unlicensed ISM (Wi-Fi for Long Distances)	100/10Mbps
Fixed LTE	100/10Mbps
Millimeter-Wave (short distances)	1.8/1.8Gbps
Mobile Broadband*	
3G (GPRS, EDGE, UMTS, HSPA CDMA)	3.1Mbps
4G LTE	100/10Mbps

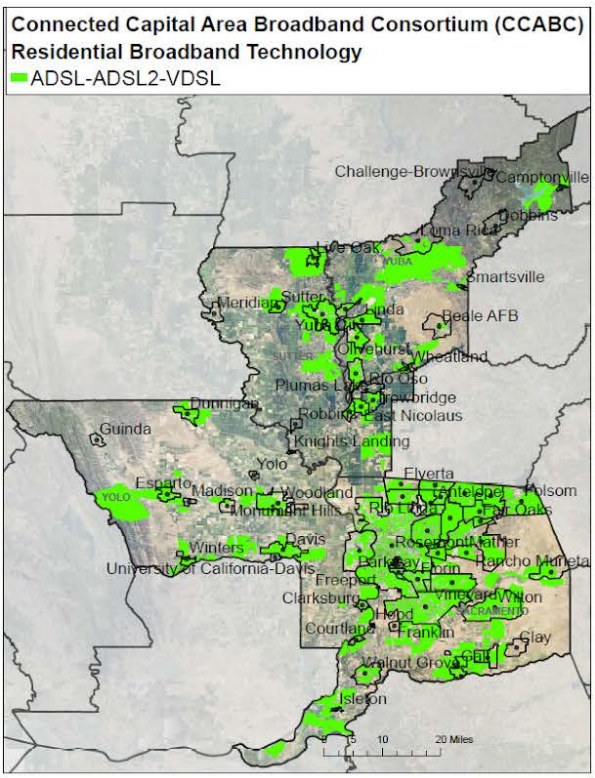
* Theoretical speeds might significantly reduce (by 5x or more) depending on line-of-sight (LOS), obstructions, spectrum interference, number of simultaneous end users, multiple access protocols, and in some cases atmospheric precipitations.

Where are these technologies offered in the Capital Region?

The maps below show the broadband internet service coverage in the Connected Capital Area Broadband Consortium (CCABC) region (Counties of Sacramento, Sutter, Yolo and Yuba) for the technologies above. We used data from the California Public Utilities Commission (CPUC) to generate these maps. The data are collected by the CPUC and self-reported from last-mile broadband service providers. In many cases, local governments, communities, residents, and other last-mile providers often have a different perception and experience of the self-reported coverage. For validation and public feedback on the broadband coverage, the CPUC has made **tools available**.

In a high level assessment, xDSL (green) is available in most urban and rural areas. Cable Modem (yellow) is mostly available in the City of Sacramento and surrounding areas, in addition to densely

populated urban areas. Fiber optics (blue) follows a similar distribution as cable modem in densely populated areas but with a smaller footprint. Finally, fixed wireless (orange) has a larger presence in rural areas. Based on this coverage, we can conclude that technologies which offer the highest speeds (fiber optics and cable modem) are mostly available in dense urban areas, and technologies with slower speeds (xDSL and fixed wireless) are mostly available in suburban and rural areas. This contrast between broadband internet coverage in urban and rural areas shows one critical aspect of the Digital Divide.


Connected Capital Area Broadband Consortium (CCABC)
Residential Broadband Technology
ADSL-ADSL2-VDSL
Challenge-Brownsville
Camptonville
Dobbins
Loma Rica
Live Oak
Smartsville
Meridian
Sutter
Linda
Yuba City
Beale AFB
Oliverhurst
Wheatland
Rio Oso
Plumas Lake
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East Nicolaus
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Ebrin
Rancho Murieta
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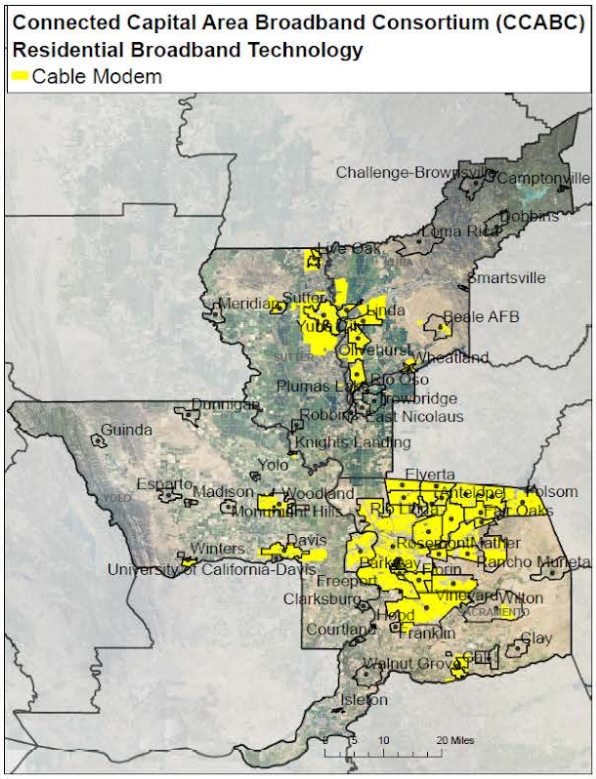
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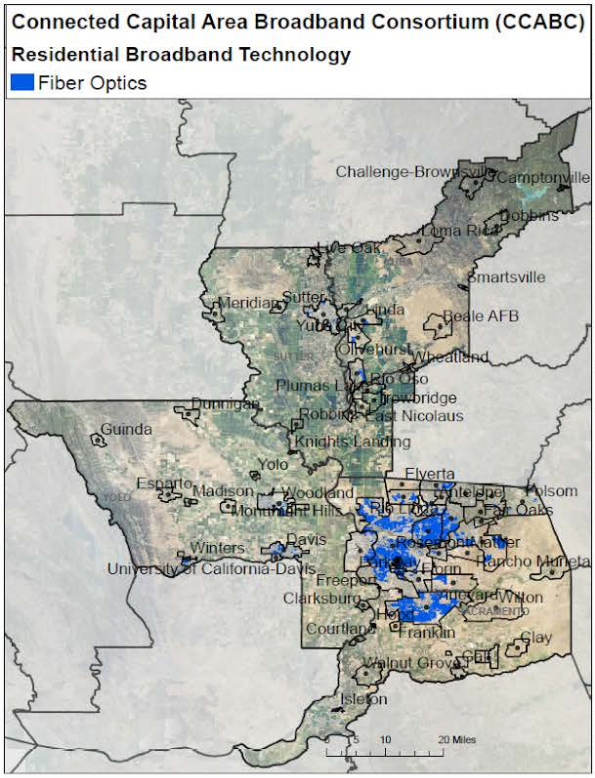
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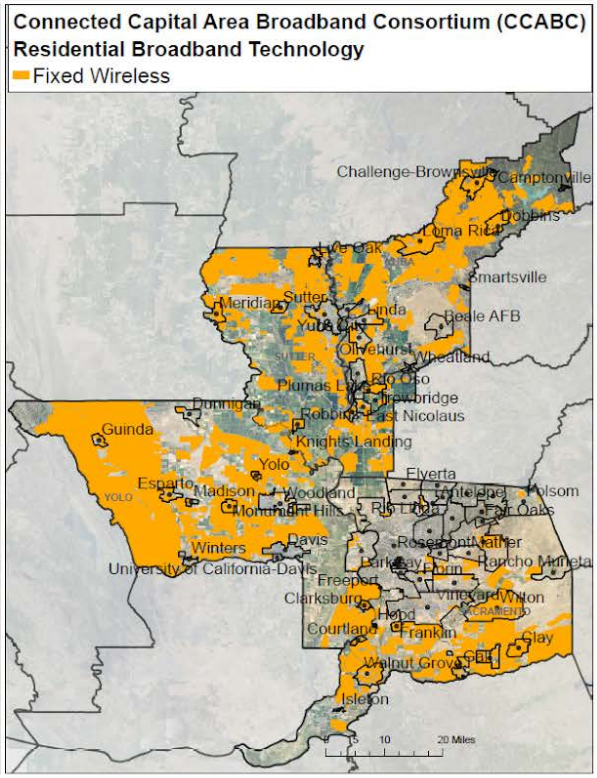
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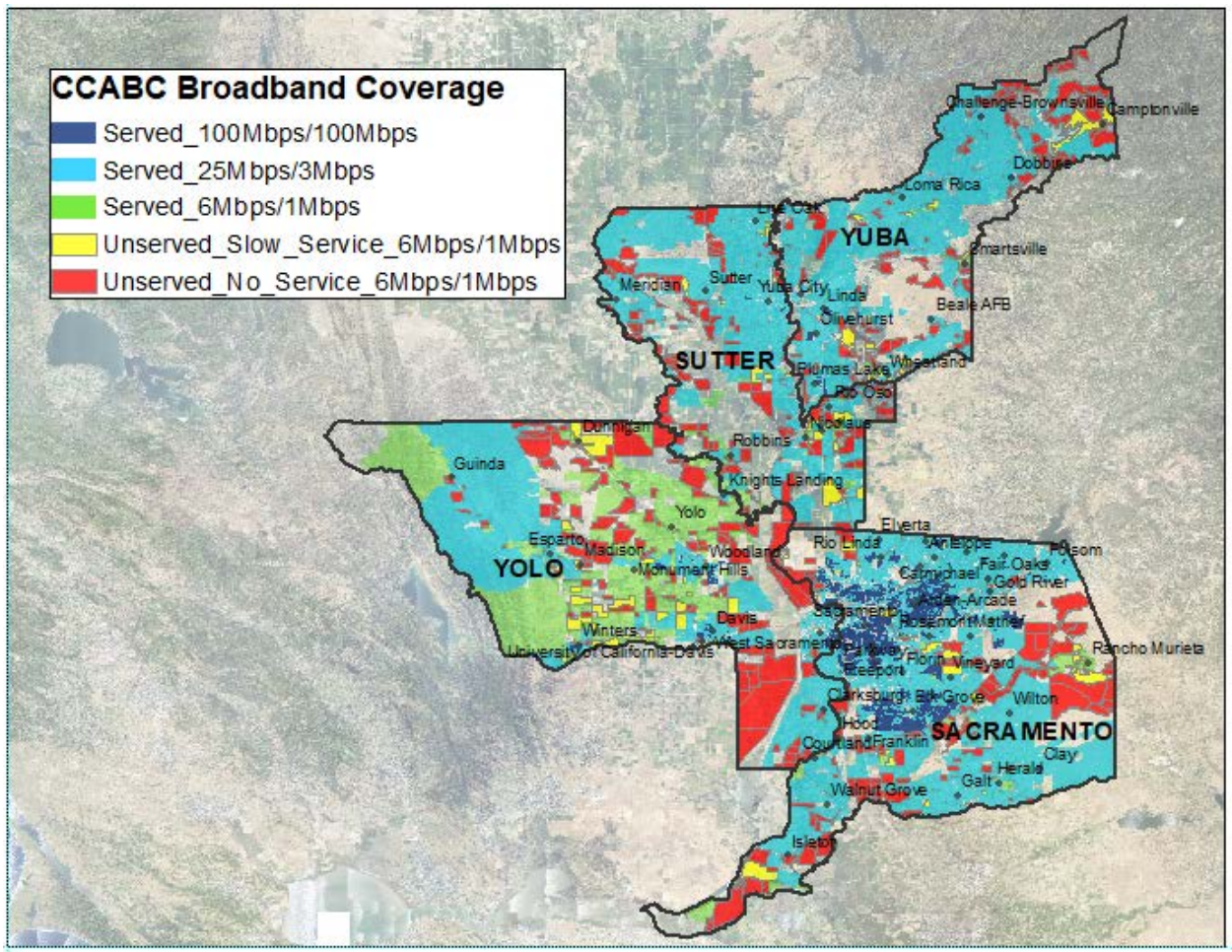
How much does it cost to deploy high-speed internet service to all households?

The table below shows the number of unserved households at 25Mbps download and 3 Mbps upload speeds (FCC broadband standard) in the CCABC region, and the estimated cost to deploy high-speed internet service (three scenarios). As noted above, 25 Mbps download is the speed needed for student and telecommuting usage and having multiple simultaneous internet users at home; therefore we used the FCC standard for the cost analysis. To calculate the cost to expand internet service to all unserved households, first we estimated the cost per household. We reviewed CPUC reports and approved California Advanced Services Fund (CASF) broadband infrastructure projects from 2013 to 2019. We calculated ranges and the average cost per household by technology and by geographical region -- as it would be less expensive to deploy in the valley than in the Sierra Nevada or Cascade Range. The average cost to provide fiber-to-the-home (FTTH) in flat terrain with moderate vegetation is $11,550; in mountainous terrain with forest, it is $23,967. In the case of fixed wireless, the average cost is $ 1,303.

The table shows that the cost to provide FTTH to all unserved households in the CCABC Region is $254.5 Million. However, in many rural areas with low household density or harsh geography, FTTH might be cost prohibitive or not feasible, or it would take several years for internet service providers (ISPs) to expand to those areas (even with infrastructure grants). In those cases, fixed wireless is a potential solution. The cost to serve all unserved households in the CCABC region with 75% FTTH and 25% fixed wireless is $197.7Million, and for 50% FTTH and 50% fixed wireless is $141 Million.

		Cost Scenarios to Serve 100% HHs at 25/3Mbps		
FCC Standard 25/3Mbps	**All Unserved Households**	**FTTH 100%**	**FTTH 75% & Fixed Wireless 25%**	**FTTH 50% & Fixed Wireless 50%**
Sacramento	13,732	$158,605,536	$123,427,351	$88,249,166
Sutter	1,205	$13,917,832	$10,830,903	$7,743,974
Yolo	4,607	$53,211,164	$41,409,103	$29,607,042
Yuba	1,567	$28,790,074	$22,103,006	$15,415,937
	CCABC Total	**$254,524,606**	**$197,770,362**	**$141,016,119**



The good news is that there are currently many broadband stakeholders working collaboratively to expand high-quality and high-speed internet service to all residents in California and our region; especially to unserved and underserved areas. The CCABC is inspired by the dedicated work of state and federal agencies, local governments and their innovative broadband task forces, regional coalitions, community anchor institutions (educational and health care organizations), community-based organizations, advocacy groups, and local champions. These broadband stakeholders are working with internet service providers (ISPs), mobile carriers, and broadband infrastructure providers to reduce the Digital Divide.

For all broadband stakeholders, achieving universal high-speed internet connectivity is a goal which will have a lasting impact on current and future generations. Now more than ever, with internet you can turn a laptop into a classroom, a computer into a doctor's office, a home office into a business. The internet connects us all and brings vast amounts of human knowledge to the reach of our fingertips. The CCABC will continue working with all broadband stakeholders to achieve the goal of universal connectivity.