BUILDING ON UC BROADBAND //

Strategies to Improve Broadband Access Throughout California

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EXECUTIVE SUMMARY

Access to high-speed broadband has become an essential enabling technology for healthy, productive lives. The disruption of the COVID-19 pandemic has revealed the disproportionate vulnerabilities that unequal broadband access presents for education, research, and university services. Even as the pandemic recedes, broadband gaps remain and will only deepen disparities if left unaddressed. Fortunately, political leaders and advocates have successfully integrated support for digital equity initiatives within economic recovery legislation, with billions in funding allocated to close the digital divide in California. The University of California (UC) should be a key partner in this effort.

UC is uniquely positioned to help support the expansion of affordable, high-quality, and equitable broadband access throughout the state. Because of its extensive geographic footprint, vast infrastructure, technical capacity, and deep ties to surrounding communities, UC can serve an important role in supporting broadband infrastructure development and adoption initiatives. In doing so, UC can leverage its unique capabilities to help the state of California close the digital divide, while simultaneously supporting its core mission to provide world-renowned teaching, path-breaking research, and meaningful public service.

Our report highlights strategies for UC to take stock of and enhance its infrastructure to support broadband access, including exploring use of innovative networking technologies to extend access to faculty, staff, and students and the broader communities it serves; strategies to streamline policies and procedures to improve broadband capacity; innovative communications and outreach models to encourage broadband adoption; and opportunities to form partnerships with the public and private sectors to leverage assets and funding opportunities. To support this work, we offer four guiding strategies and corresponding recommendations UC should consider:

- **Enhance infrastructure & streamline policies**
- **Strengthen services and programs enabled by broadband**
- **Establish tailored communications and outreach campaigns**
- **Grow partnerships with the public and private sectors**

This report builds upon key insights from interviews with government, industry, and academic experts and from the UC Broadband Working Group, composed of chief information officers and chief innovation officers within the University of California Office of the President (UCOP) and UC Agriculture and Natural Resources; directors from UC Institutes of Science and Innovation, including CITRIS and the Banatao Institute (CITRIS) and the California Institute for Telecommunications and Information Technology (Calit2); leadership from state agencies focused on broadband inclusion, such as the California Department of Technology and the California State Transportation Agency; and leadership from the Corporation for Education Network Initiatives in California (CENIC), the primary provider of high-speed broadband service to UC campuses and the administrator of GoldenStateNet, California's publicly-funded middle-mile network.

INTRODUCTION

In October 1969, the world's first network connection—what would later become the internet—was established between UCLA and Stanford. While these connections have expanded globally over the last five decades, sizable populations are still unconnected or under-connected.[1] Just as in 1969, universities can play an influential role in closing the digital divide and reducing digital inequality.

High-speed broadband is not only essential infrastructure for university research, teaching, and learning, a dependency highlighted during the COVID-19 pandemic when most instructional and operational activities were forced online.[2] Broadband access is a cornerstone of socio-economic inclusion, especially in low-income areas and more rural areas of the state. Despite California's history of digital innovation, digital divides remain and are found disproportionately among certain demographic groups, such as African American and Latino communities and low-income households.[3] Communities in large regions of the state face limited economic opportunity in part because they lack access to high-speed internet. In these areas, un- or under-connected residents face significant disadvantages when trying to access increasingly common services such as telehealth, online education, and remote employment opportunities.[4]

Because of its vast infrastructure and widespread geographic footprint, the University of California (UC) is well positioned to help close the digital divides that affect the state. UC spans nearly 30,000 acres across its ten campuses, six health systems, three national laboratories, over 70 Agriculture Natural Resources locations, and more than 5,800 buildings.[5] An additional 47,000 acres are managed by the university within the Natural Reserve System.[6] UC's extensive reach throughout the state may enable it to implement innovative broadband deployment strategies, such as long-range Wi-Fi or local wireless mesh networks that can provide free or subsidized access to surrounding communities in urban and rural areas. These networks are being piloted in various parts of California and elsewhere and show great promise. Given the

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[1] Vikki S. Katz, "What it means to be 'under-connected' in low-income families," *Journal of Children and Media,* 11, no. 2 (2017): 241-244. https://www.tandfonline.com/doi/abs/10.1080/17482798.2017.1305602?journalCode=rchm20.

[2] The Federal Communications Commission defines Broadband internet – which includes wireless, cable, DSL, fiber optic, or satellite – as the ability to download at a rate of 25 megabits per second and upload at a rate of at least 3 megabits per second. See Federal Communications Commission, "2015 Broadband Report," February 4, 2015, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report.

[3] Niu Gao and Joseph Hayes, "California's Digital Divide," *Public Policy Institute of California,* Feb. 2021, https://www.ppic.org/publication/californias-digital-divide/.

[4] "CETF 2021 Statewide Broadband Adoption Survey," California Emerging Technology Fund, June 1, 2021, https://www.cetfund.org/action-and-results/statewide-surveys/2021-2/.

[5] "Campuses & locations," University of California, accessed April 18, 2022, https://www.universityofcalifornia.edu/campuses-locations.

[6] "University of California 2015 Accountability Report: Capital Program and Sustainability," University of California, 2015, https://accountability.universityofcalifornia.edu/2015/chapters/chapter-13.html.

expert faculty and staff who build and maintain this infrastructure, and their deep ties to surrounding communities, UC could further serve a catalyzing role in outreach, training, and workforce development.

Although UC leads in innovation, gaps in access persist in areas near UC campuses and other facilities. While anecdotal evidence suggests such shortfalls, no systematic mapping and analysis of these gaps is publicly available. Even the California Public Utilities Commissions (CPUC) Interactive Broadband Map provides limited public data.[7] Non-disclosure agreements between ISPs and CPUC restrict the broadband connectivity data that can be publicly shared.[8] Unfortunately, this situation hampers UC's ability to identify broadband gaps and points to the need for further data collection on the quality and availability of service near UC campuses and other facilities.

Under-connectivity became a notable issue for UC students during the pandemic and existing data shows that broadband access rates are clearly affected by race and economic status.[9] In the University of California Undergraduate Experience Survey (UCUES) focused on COVID-19 and remote learning, administered at the height of the pandemic, 33% of students were either "concerned" or "very concerned" about having consistent access to internet service for remote learning. However, the gap was most prominent with low-income students where 40% of Pell Grant recipients were "concerned" or "very concerned" about their access to the internet in comparison to 28% of non-Pell Grant recipients.[10] In addition, 38% of Black students were "concerned" or "very concerned" about reliable access to the internet compared to 27% of white students.[11] UC responded to this need by providing students with access to no-cost internet hotspots, laptops, and tools for digital learning such as noise-canceling headphones.[12] Campus IT departments also provided assistance to staff and faculty during the transition to remote work and teaching to help close the divide for the entire UC community.[13] These efforts build on

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[7] California Public Utilities Commission, "California Interactive Broadband Map," accessed April 9, 2022, https://www.broadbandmap.ca.gov/.
[8] California Public Utilities Commission, "Nondisclosure Agreement Regarding Confidential Materials," Oct. 2019, https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpucwebsite/content/utilitiesindustries/communications/serviceproviderinfo/casf/casf_adoption/adoption-account-nda.pdf.
[9] "Undergraduate UCUES COVID–19 and remote learning dashboard," University of California, accessed April 18, 2022, https://www.universityofcalifornia.edu/about-us/information-center/ucues-covid-19.
[10] Ibid.
[11] Ibid.
[12] Gretchen Kell, "Campus, going remote, provides $4.6 million in tech to students in need," *Berkeley News,* July 21, 2020, https://news.berkeley.edu/2020/07/21/campus-going-remote-provides-4-6-million-in-tech-to-students-in-need/; Cody Kitaura, "UC Davis provides loaner laptops to students in need: IET, stores and donors contribute to the cause," *UC Davis,* March 20, 2020, https://www.ucdavis.edu/coronavirus/news/uc-davis-provides-loaner-laptops-students-need.
[13] Ibid.

previous innovative approaches to closing the digital equity gap, such as UC Berkeley's Technology Access and Student Technology Equity Programs.[14]

Various initiatives have been launched in recent years by the state of California to both close the digital divide and support future broadband expansion efforts. The California Broadband Council was established in 2010 and has since emerged as a leading entity on the deployment of broadband to unserved and underserved regions throughout the state.[15] In response to Executive Order N-73-20, the California Broadband Council expanded these efforts in 2020 with the creation of the California Broadband for All Action Plan, which outlines both the existing challenges for expanding access and clear goals for the state to ensure all Californians have high-performance broadband available at home, schools, libraries, and businesses by expanding access to affordable internet service and devices and digital literacy training.[16] To support these goals, Governor Newsom signed SB 156 in July 2021 which allocated $3.25 billion and directed the California Department of Technology (CDT) to establish the Middle-Mile Broadband Initiative. To do this, CDT has partnered with CENIC to build "GoldenStateNet," a statewide, open-access middle-mile network.[17] SB 156 also allocated $2.75 billion to build last-mile infrastructure, to be administered by CPUC.

With a focus on broadband at both the state and federal levels, UC has an opportunity to collaborate with other public and private sector entities and emerge as a leader on issues related to digital inclusion. Significant funding opportunities are available now and will continue to emerge over the years ahead; for example, NTIA's Broadband Equity, Access and Deployment (BEAD) program will provide an initial allocation of $100 million to California to support its California Broadband for All Action Plan.[18] This significant influx of funding presents an opportunity for university leadership to take action. Given the availability of funding and strengthened political will to close the digital divide, we recommend focusing attention and resources to develop the four strategies described below.

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[14] "Overview Berkeley Student Technology Fund," UC Berkeley, accessed March 13, 2022, https://techfund.berkeley.edu/about/overview.
[15] "The California Broadband Council," State of California, accessed March 13, 2022, https://broadbandcouncil.ca.gov/.
[16] "California State Broadband Action Plan," California Broadband Council, accessed April 18, 2022, https://broadbandcouncil.ca.gov/action-plan/.
[17] "State selects third-party administrator for broadband middle-mile network," California Department of Technology, Sept. 2, 2021, https://cdt.ca.gov/news/state-selects-third-party-administrator-for-broadband-middle-mile-network/.
[18] "Broadband Equity, Access, and Deployment (BEAD) Program," National Telecommunications Administration (NTIA), accessed April 12, 2022, https://broadbandusa.ntia.doc.gov/broadband-equity-access-and-deployment-bead-program.

FOUR GUIDING STRATEGIES FOR IMPROVING BROADBAND ACCESS

UC is uniquely positioned to catalyze the expansion of access to affordable and high-quality broadband, aligned with its mission to serve California through education, high-impact research, healthcare access, and public service. As this work moves forward, the following strategies should guide UC's plans to improve broadband access throughout the state:

- **Enhance infrastructure and streamline policies**
- **Strengthen services and programs enabled by broadband**
- **Establish tailored communications and outreach campaigns**
- **Grow partnerships with the public and private sectors**

Infrastructure

Physical Infrastructure & Facilities

While UC's physical footprint is expansive, an infrastructure audit would help to provide a robust inventory of available UC assets, including type of infrastructure and whether it is capable of supporting broadband technologies. Such a study could also document any existing agreements governing the use of the infrastructure (e.g., established contractual agreements with ISPs). Plans to expand broadband may require physical infrastructure to be built into the affected communities through various methods such as trenching to lay fiber, erecting towers to transmit wireless signals, and installing transmitters. UC has access to the physical infrastructure and facilities that could further this work.

UC ANR is particularly well positioned to support broadband inclusion efforts in rural areas where ISPs may be less likely to roll out last-mile coverage. The state legislature has previously expressed interest in UC ANR expanding access to broadband services via public-private partnerships in rural areas; however, a lack of sustainable funding has prevented this type of project from moving forward.[19] Increased state support for UC ANR in future years could allow for further investments in these areas to provide last-mile coverage (See Figure 1).

[19] "Youtsey testifies on rural broadband for Assembly committees," ANR Employee News, Sept. 14, 2017, https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=25207.

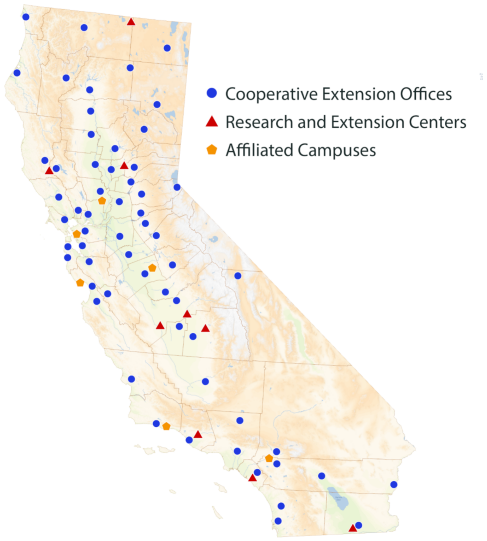

Figure 1. "Map of UC ANR facilities,"
UC ANR Strategic Plan, January 2017.

The recent infusion of federal and state funds has sparked development of new organizational entities, such as GoldenStateNet, a network created by CENIC's California Middle-Mile Broadband Initiative.[20] This $3.25 billion investment by the state will:

- Provide affordable, open-access, middle-mile broadband infrastructure to enable last-mile network connectivity throughout California.
- Build the network expeditiously, leveraging existing infrastructure, networks, and construction projects, wherever feasible.
- Prioritize connectivity to unserved and underserved communities, including community anchor institutions.[21]

As a first step, GoldenStateNet has developed a series of broadband availability maps to identify underserved and unserved areas and primary locations for a middle-mile network.[22] UC is well positioned to serve as an active and effective partner to realize these infrastructure goals due to existing relationships with CENIC and other educational institutions. The California State University system, California Community Colleges, private universities, K-12 schools, hospitals and libraries are connected to the internet backbone via the California Research and Education Network (CalREN) administered by CENIC. Nearly all these facilities, with the exception of a few UC ANR locations, use CENIC's broadband service.

[20] "State selects CENIC California MMBI as Third-Party Administrator for Broadband Middle-Mile Initiative," CENIC blog, September 2, 2021, https://cenic.org/news/state-selects-ccmmbi.
[21] "Golden State Net,"accessed April 18, 2022, https://goldenstatenet.org/.
[22] "Statewide Middle-Mile Network Design," GoldenStateNet, April 22, 2022, https://cdt.ca.gov/wp-content/uploads/2022/04/GSN-Statewide-System-Level-Design-04222022.pdf.

What is Microtrenching?

Microtrenching is the process of installing fiber optic cable along the sides of sidewalks and roads via small and shallow trenches. It is a cheaper, less disruptive, and faster alternative to traditional trenching and does not require completely digging up roads or sidewalks.[23] In contrast to traditional trenching, microtrenched fiber is usually much closer to the surface.

While there are benefits to using microtrenching in some areas to provide last-mile connections, considerations regarding the use of this technique include:

- If fiber is not properly marked or mapped by local jurisdictions, new construction can result in lines being cut or damaged during routine processes such as road repaving.[24]
- Further research is needed on longevity of equipment and long-term effects of vehicular travel on microtrenched fiber.

In addition, UC could serve as a resource for the California Department of Transportation (CalTrans) as it renews efforts to build out middle-mile and last-mile connections through the state highway system. CalTrans is currently in the process of developing a microtrenching policy for statewide use; however, due to the infancy of the technology they lack quality information on the longevity of the fiber, or the maximum vehicle speeds that should be allowed on microtrenched roads to mitigate damage to the fiber.[25] UC could be a valuable resource for the state as a research partner, conducting experiments and developing models that can provide more accurate information as the state develops this policy.[26] If successfully adopted, increased use of microtrenching would allow ISPs to use the process developed by CalTrans to lay fiber alongside existing roadways and expand access to wired broadband infrastructure in additional regions of the state.[27]

[23] "NYC Department of Information Technology & Communications: Microtrenching," NYC DoITT, accessed March 10, 2022, https://www1.nyc.gov/site/doitt/business/microtrenching.page.

[24] Tony Gonzalez, "Google Fiber Disruptions Have Some Saying 'I Told You so' about Buried Cables," *WPLN News*, December 26, 2019, https://wpln.org/post/google-fiber-disruptions-have-some-saying-i-told-you-so-about-buried-cables/.

[25] Lori Pepper, interview by author, January 24, 2022.

[26] For example, the University of California's multi-campus Institute for Transportation Studies includes faculty and experts in many related areas, https://www.ucits.org/.

[27] "Incorporating Wired Broadband Facility on State Highway Right-of-Way, Users Guide," *California Department of Transportation (Caltrans),* January 1, 2018, https://dot.ca.gov/-/media/dot-media/programs/design/documents/wired-broadband-facility-user-guide–1-01_edition-a11y.pdf.

Wireless Infrastructure

Services such as Eduroam, a secure wireless service for universities and researchers throughout the world, may be a good model to connect low-income households or underserved communities in California or elsewhere. While promising, open-access networks must have appropriate safeguards for cybersecurity for both the network integrity as well as protecting the users' data and activities. Cybersecurity protections, like a sign-in system that collects user information to vet and enroll community members, along with measures like encryption to increase the safety of using the publicly accessible network, are promising.[28] With appropriate safeguards in place to monitor traffic and activity, UC could partner with an ISP like CENIC to develop a similar open-access wireless network program.

Another option for expanding wireless access to the general public is to leverage innovative network technologies, such as long-range WiFi, radio frequency (RF)-over-fiber, or wireless mesh networks.[29] For example, US Ignite's Project Overcome (funded by NSF and Schmidt Futures) is supporting two communities and their local universities to expand broadband access free of charge.[30] The University of Buffalo (New York) will use newly available spectrum from Citizens Broadband Radio Service (CBRS) to create a WiFi network among nodes placed in residents' homes throughout the city. In western Missouri, higher education institutions and their extension offices will use RF-over-fiber to provide high-speed broadband connections to the last mile. The program is also partnering with the local 4-H to provide digital literacy training for families and businesses with the goal of spurring economic growth and rural entrepreneurship.[31]

UC is well positioned to pursue similar innovative networking models, such as deploying long-range Wi-Fi or local wireless mesh networks that can offer free or subsidized internet access to surrounding communities. As an example, the "NYC Mesh" program uses mesh networking technology to support a community-owned broadband program.[32] In this model, household-level nodes are connected to one another through rooftop wireless routers. Fiber is also used in some neighborhoods to extend access where high-quality wireless is unavailable.[33]

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[28] Bree Fowler, "Is using public WiFi still a bad idea?" *Consumer Reports,* April 12, 2019, https://www.consumerreports.org/digital-security/is-using-public-wifi-still-a-bad-idea-a8476049516/.
[29] See this presentation for an overview and description of various wireless technologies: George Dolidze and Gary Kazaryan, "Wireless technologies: CENIC report to the board," *CENIC,* Sept. 23, 2020, https://events.cenic.org/files/publication-images/CENIC-Wireless-Technologies_Board-Presentation-1.pdf.
[30] "Project OVERCOME: Innovative Connectivity Solutions in Seven Communities," the Benton Institute for Broadband & Society, October 2021, https://www.benton.org/sites/default/files/project_overcome.pdf.
[31] Jacob Douglas, "Internet 'Last Mile' Experiment Coming to Clinton County," *Flatland,* April 13, 2021, https://www.flatlandkc.org/news-issues/internet-last-mile-experiment-coming-to-clinton-county/.
[32] NYC Mesh, accessed April 18, 2022, https://www.nycmesh.net/.
[33] Ibid.

Wireless mesh networks have already been piloted in California, including at UC San Diego, and show great promise.[34] Mesh networking technology is currently being tested at the UCSD campus to expand broadband access in the San Diego Promise Zone, an ethnically diverse and low-income area within the city, in addition to other strategic programs being launched to support economic development in the region. While this project is currently in early stages, it could be replicated once the model is prototyped and tested. Current efforts in San Diego are being supported by private philanthropy, and UC could facilitate similar expansion projects with philanthropic or public funding.[35] The timeline for these projects can be quite fast. The city of San Rafael was able to implement a mesh network providing free high-quality internet to residents with school-age children in less than a year. The project's costs were also affordable, roughly $190,000 in one-time costs for hardware and on-going annual expenses projected to be $55,000.[36]

To expand its reach to the wider community, UC may want to explore partnering with K-12 educational institutions. In Riverside, Val Verde Unified School District recently launched a pilot program for a public-private partnership that will support provision of broadband service to families of enrolled students over a 5-mile zone using a variety of technologies including wireless mesh networking. The project will use $5 million in funds from the school district to connect 1,400 families to the internet at no cost for a five-year period.[37] UC could explore partnerships with K-12 schools to expand their reach and impact throughout the community (it is in UC's interest to improve the quality of life in surrounding areas to enhance recruitment and retention of faculty, staff and students). In doing so, UC may be able to utilize additional infrastructure that can expand wireless network access well beyond its geographic footprint, tap into new funding opportunities, and provide valuable technical and administrative support to a greater portion of its community.

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[34] See the CENIC report "Wireless Internet Technologies for Access, Equity and Continuity," Oct. 16, 2020, for a description of a wireless mesh network piloted in San Rafael in summer 2020: https://cenic.org/blog/wireless-internet-technologies-for-access-equity-and-continuity.

[35] "Mohuman Selected as a Summer 2021 Grantee from the Conrad Prebys Foundation to Bridge the Digital Divide in the San Diego Promise Zone," *Mohuman*, September 16, 2021, https://mohuman.org/mohuman-selected-as-a-summer-2021-grantee-from-the-conrad-prebys-foundation-to-bridge-the-digital-divide-in-the-san-diego-promise-zone/.

[36] Ry Marcattilio-McCracken, "How San Rafael, California Built a Neighborhood Mesh Network That Turned into Something More," *Community Broadband Networks,* September 3, 2020, https://muninetworks.org/content/how-san-rafael-california-built-neighborhood-mesh-network-turned-something-more.

[37] "CENIC: Val Verde School District Broadband Network Provides Case Study for Closing the Digital Divide," *CENIC,* March 9, 2022, https://cenic.org/blog/val-verde-school-district-broadband-network-provides-case-study-for-closing-the-digital-divide.

What are Wireless Mesh Networks?

Mesh networking is a network topology that could be further deployed by the university to provide broadband to the greater community. Wireless mesh networks allow an entity to carry broadband signals out to the community via "nodes," devices installed in locations such as rooftops that transmit a secure and strong signal between the node network and users. Mesh networks also solve the problems typically associated with Wi-Fi extender devices which may reduce bandwidth through the process of rebroadcasting (in order to amplify) a signal.[38] In contrast, mesh networks create a new signal rather than amplifying an existing signal.

This technology has traditionally been deployed during natural disasters and blackouts, when mesh networks offer emergency responders an immediate way to connect when power lines and cell towers are inoperable.

Streamlining Infrastructure Policy

While the relative costs of deploying innovative networking technologies can be significantly lower than traditional broadband infrastructure investments, UC should consider opportunities to develop policies and practices that streamline operations, lower overhead costs and develop sustainable funding models with partners. This system-level guidance can offer models and templates to individual campuses as they embark on novel infrastructure projects and partnerships. Likewise, the system-level office may benefit from examples tested on individual campuses to date.

The UC San Diego campus has successfully developed internal policies to streamline its operations. One such example is the campus's initiative to lay fiber when any trenching has taken place on the main campus. Another is through the negotiations to lay fiber during the construction of the UC San Diego Blue Line Trolley Extension in order to provide a high-speed and secure internet connection between the campus and its new downtown extension building. As a result, the UC San Diego Blue Line Trolley Extension project not only connected the campus to the broader community but also included additional fiber laid during the trenching of the project. While this fiber is currently being used to provide a high-speed and secure connection for research purposes, future investments could include broadband access to the wider community.

[38] "What's the Difference: WIFI Booster, Repeater or Extender?" *Waveform,* accessed March 12, 2022, https://www.waveform.com/pages/wifi-booster-repeater-extender-differences.

UC San Diego is also supported by a series of National Science Foundation grants to run the High-Performance Wireless Research and Education Network (HPWREN) in rural areas of San Diego, Riverside, and Imperial County. HPWREN uses FCC-licensed radio spectrum technology that allows better service in rural and mountainous areas and provides a continuous connection for researchers and their rural research stations.[39] Similar efforts could be undertaken to replicate HPWREN and create regional open networks that increase access to additional rural Californians.

Recent opportunities have emerged to align policies and procedures for robust broadband deployment. For example, as part of the Statewide Rural Connectivity Project, the California State Parks have developed a streamlined process for requests for proposals (RFP) that UC could explore to access funds for data gathering or research efforts to further broadband connectivity in rural areas of the state. In addition, the funds could be used to increase connectivity at rural UC-owned facilities.[40] Additionally, UC capital projects with a community development component, such as UC Davis's Aggie Square, could include established policies and procedures for ensuring fiber and broadband points-of-access for the neighboring community. Creating a UC broadband "community of practice" could help CIOs, CTOs, CISOs, government relations staff, procurement officials, and other stakeholders share information and reduce friction in future projects.

Services & Programs

Expanding cyberinfrastructure and digital inclusion will enable UC to extend and enhance its services and programs throughout the state. UC could improve broadband access and affordability for its own constituents (faculty, staff, and students) as well as for the broader community, including by tapping into broadband subsidy programs. During the height of the pandemic, several new federal and state broadband funding programs opened, such as the Emergency Broadband Benefit Program and its replacement, the Affordable Connectivity Program, to provide struggling households with much-needed financial support for broadband subscriptions.[41] UC can play an essential role in supporting access to services such as telehealth, online education and workforce development, research, and public safety.

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[39] "About the High-Performance Wireless Research and Education Network," UCSD, accessed April 18, 2022, https://hpwren.ucsd.edu/about.html.
[40] Patrick Quarry, Amanda Radmand, & Patrick Dennis, California State Parks, interview by author, December 17, 2021.
[41] Tyler Cooper, "Understanding the Affordable Connectivity Program," *Broadband Now,* Jan. 18, 2022, https://broadbandnow.com/report/affordable-connectivity-program/.

Telehealth

Emerging literature suggests that broadband should be considered a social determinant of health.[42] The ability of UC health patients and care providers to access high-quality broadband is directly linked to the quality of care available via telehealth. Considering the sizable reach of the UC Health System and its recognition as a world leader in virtual medicine, it is important to consider the necessary expansion of telehealth capacity in less-accessible communities.[43] In particular, rural communities are most affected by low-quality broadband access.[44] Some work has been done on this topic internally through the UC Office of the President to examine feasibility of expanding telehealth services to additional members of the UC community.[45] These efforts have been accelerated by the COVID-19 pandemic and are being discussed at the statewide level, including with members of the legislature. The state of California has convened a telehealth advisory working group through the Department of Health Care Services to examine feasibility for increasing telehealth access through the Medi-Cal program.[46]

For campuses, the provision of telehealth, primarily for services such as mental health counseling, can increase the accessibility of such services for students beyond the physical campus and regular working hours. Since the start of the pandemic, UC has taken action to increase availability of telehealth services, most recently with the approval of a UC Telehealth Collaborative to focus on expanding virtual mental health services to students on the UC SHIP healthcare plan.[47]

Through the Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS), a pilot program funded by a private donor has been launched at two affordable housing communities in California's Central Valley where both digital literacy training and high-speed broadband access have been provided to low-income senior residents for the purpose of expanding access to care.[48] This innovative partnership model has shown promising results that may be scalable to other UC broadband expansion efforts. By combining broadband access with digital literacy training and engagement with trusted community health providers,

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[42] Natalie C. Benda, Tiffany C. Veinot, Cynthia J. Sieck, and Jessica S. Ancker, "Broadband Internet Access Is a Social Determinant of Health!" *American Journal of Public Health* 110 (2020): 1123-1125, https://doi.org/10.2105/AJPH.2020.305784.

[43] University of California, "UC Health Update on Virtual Care (Telehealth) Innovations," https://regents.universityofcalifornia.edu/regmeet/jan21/h3.pdf.

[44] Graves, J. M., Abshire, D. A., Amiri, S., & Mackelprang, J. L., "Disparities in Technology and Broadband Internet Access Across Rurality: Implications for Health and Education," *Family & Community Health* 44 no. 4 (2021): 257–265, https://doi.org/10.1097/FCH.0000000000000306.

[45] Eric Kessell, "Telehealth for all UC," UC IT blog, Nov. 17, 2015, https://cio.ucop.edu/telehealth-for-all-uc/.

[46] "Telehealth Advisory Workgroup," DHCS Telehealth Advisory Workgroup (California Department of Health Care Services), accessed March 7, 2022, https://www.dhcs.ca.gov/provgovpart/Pages/TelehealthAdvisoryWorkgroup.aspx.

[47] UC Regents Health Services Committee Meeting Agenda, "Remote services offered at student health and counseling," December 2020, https://regents.universityofcalifornia.edu/regmeet/dec20/h11.pdf.

[48] "Lighthouse for Older Adults," CITRIS and the Banatao Institute, April 22, 2021, https://citris-uc.org/research/project/lighthouse-for-older-adults/.

low-income seniors and the staff who serve them have gained improved broadband access and put it to use in meaningful ways.

Online Education & Economic Development

UC has been engaged in providing online education even before the pandemic required all instruction to go online. Given the competing pressures on many campuses — both to enroll more students and ensure that in-person instruction does not exceed local housing supply — high-quality online education will be an increasingly important strategy for the university. At this point, UC offers some undergraduate courses online through the UC Online cross-campus enrollment program, as well as a wide variety of fully-online and hybrid graduate degrees.[49] The nine UC extension programs also have online course offerings and certificates. These programs will likely be expanded in coming years and will require a reliable high-speed broadband network and devices to deliver content and facilitate interaction. Student associations from UC and CSU, as well as research and advocacy organizations like Education Trust-West highlighted the shortfalls in the FCC's minimum definition of broadband (25 mbs download and 3 mbs upload) for households with multiple students trying to participate in online learning activities simultaneously; many of their requests and recommendations sent to the Broadband Action Council in November 2020 are echoed here.[50] If the university wants to increase its delivery of online courses, it should simultaneously identify effective strategies for supporting equitable broadband access throughout the communities it serves.

UC campuses are important drivers of economic development at the local level. Most campuses offer programs in innovation and entrepreneurship or related topics to prepare students to create their own companies or join established organizations as active members of the workforce upon graduation. An estimated 1,267 UC-affiliated startups were created between 1967 and 2015 (with several hundred more since then). These companies attracted an estimated $16.3 billion in investment, created nearly 150,000 jobs and added $20 billion to the California economy.[51] This analysis included only companies in STEM-related fields, and many of them undoubtedly rely on broadband access for their work, directly or indirectly. UC could eventually tap into the strong innovation ecosystem within the UC alumni network to assist in the expansion of broadband through piloting new products and services developed by alumni and their respective companies.

[49] "UC Online," accessed April 18, 2022, https://uconline.edu/.
[50] Adolfo Guzman-Lopez, "Broadband relief coming for some college students under federal relief plans," *LAist*, January 11, 2021, https://laist.com/news/state-federal-progams-broadband-internet-college-students.
[51] "Entrepreneurs, Startups and Innovation at the University of California," Bay Area Council Economic Institute, August 2016, http://www.bayareaeconomy.org/report/entrepreneurs-startups-innovation-at-uc/.

Research

Faculty members and other researchers will increasingly rely on secure high-speed broadband for research in agricultural technology, robotics, aviation, communications, geophysical disciplines, infrastructure monitoring, and more. HPWREN (mentioned above) is being deployed as part of an extensive wildfire monitoring system (WiFIRE), also based at UC San Diego, to provide early warning using machine vision, remote sensing, and machine learning applications to detect wildfires at their earliest stages.[52] The new NSF-funded Institute for Agricultural AI for Transforming Workforce and Decision Support (AgAID) at UC Merced will require high-speed broadband to move data from the field equipment and instruments to data servers and labs.[53] Similarly, drones or Uncrewed Aerial Vehicles (UAVs) may gather sensing data or imagery that will require a robust broadband connection to transmit field data securely.

Other applications could include sensors deployed in cables for monitoring bridges, highways, and other transportation infrastructure. These devices can sense not only the health and durability of the facilities but also serve as an earthquake early warning system for the local area. Likewise, applications for monitoring the Sierra snowpack and water supply are increasingly being automated and will rely on secure internet connections for gathering and reporting data to relevant decision makers.

Public Safety

Many of the applications described above such as natural hazard early warning systems and transportation infrastructure have important public safety applications that UC could support through expanded broadband access and quality. The recent wildfires through Sonoma and Napa counties illustrated the extent to which climate resiliency and infrastructure are interconnected. When wildfires swept through the region, not only were homes and businesses burned, but technologic infrastructure such as cell towers and broadband fiber were also damaged thus preventing residents from being able to use these critical services during an emergency.[54] California communities need to know when their neighborhoods might be threatened by wildfire and they must evacuate or when an earthquake is imminent and they should take cover. Improving end-to-end broadband connections will make communities safer. In San Rafael, the mesh networking used to expand broadband access to low-income residents is also being

[52] WiFIRE, accessed April 18, 2022, https://wifire.ucsd.edu/.
[53] Lorena Anderson and Sara Zaske, "New AI institute expands UC Merced's smart, sustainable agriculture effort," *UC Merced,* July 29, 2021, https://news.ucmerced.edu/news/2021/new-ai-institute-expands-uc-merced%E2%80%99s-smart-sustainable-agriculture-effort.
[54] Bryan Mena, "California Wildfires Can Bring Internet Outages. Some Want Networks to Be Tougher," *San Francisco Chronicle,* September 30, 2020, https://www.sfchronicle.com/business/article/California-wildfires-can-bring-internet-outages-15610411.php.

attached to generators so that important communications can be pushed out to residents' cellular devices and social media channels during emergencies.[55]

Outreach & Communications

California legislators and other elected leaders have shown a strong dedication to develop programs that further the public interest and provide workforce development opportunities for young adults. Notably, Governor Gavin Newsom has made the creation of a new state office through "California Volunteers" a key initiative of his administration in order to couple work-based learning with public service opportunities. Following on the AmeriCorps model, the new #CaliforniansForAll College Corps currently focuses on K-12 education, climate action and food insecurity, but could be expanded to include digital inclusion as a priority area.[56] UC is currently partnering with California Volunteers to pilot the #CaliforniansForAll College Corps at seven of its nine undergraduate campuses.[57] In the future, UC could tap into its own technical capacity and student workforce, and use this model to serve the greater community through public service projects to improve digital literacy and high-speed broadband coverage throughout the state. UC could launch its own program, a "Connect California Corps," in which students could serve as digital navigators and work with community organizations on efforts to strengthen access and tap into federal and state broadband funding to improve digital literacy and education throughout California. This effort could be done in coordination with the #CaliforniansForAll College Corps or could be administered through the UC Institutes for Science and Innovation, such as CITRIS, which recently launched its Workforce Innovation Program to provide internship opportunities to undergraduates.[58] In building this type of programming, UC can also look to national outreach models led by industry. For example, in February 2022 Google partnered with the National Digital Inclusion Alliance to launch a National Digital Navigator Corps program to train "digital navigators" who support digital inclusion in rural and tribal communities throughout the country.[59]

ISPs and state government programs currently offer opportunities to expand access to broadband through subsidy programs. However, eligible individuals and institutions that lack

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[55] Ry Marcattilio-McCracken, "How San Rafael, California Built a Neighborhood Mesh Network That Turned into Something More," *Community Broadband Networks,* September 3, 2020, https://muninetworks.org/content/how-san-rafael-california-built-neighborhood-mesh-network-turned-something-more.

[56] "#CaliforniansForAll College Corps," California Volunteers, Office of the Governor, accessed April 18, 2022, https://www.californiavolunteers.ca.gov/californiansforall-college-corps/.

[57] Ibid.

[58] "Workforce Innovation Program," CITRIS and the Banatao Institute, accessed April 14, 2022, https://citris-uc.org/labs-programs/citris-workforce-innovation/.

[59] Yvette Scorse, "NDIA Announces $10 Million Grant from Google.org to Remove Digital Divide Roadblocks for Rural & Tribal Communities," *Digital Inclusion News,* Feb. 15, 2022. https://www.digitalinclusion.org/blog/2022/02/15/ndia-announces-10-million-grant-from-google-org-to-remove-digital-divide-roadblocks-for-rural-tribal-communities/.

technical or administrative capacity are unlikely to apply. Despite available financial support, an estimated 23 percent of California households do not have broadband subscriptions.[60] These low broadband adoption rates are highly correlated with both income and race per a June 2019 study by the California Public Utilities Commission.[61]

The federal government also offers subsidy programs to increase the affordability and accessibility of broadband internet services. The FCC has developed and launched the Affordable Connectivity Program to subsidize both internet services and computing devices to households with incomes that fall below 200% of federal poverty guidelines or if a household member qualifies for other Temporary Aid For Needy Families (TANF) social services, such as a federal Pell Grant.[62] As a result, most low-income UC undergraduates and their families are eligible for a monthly subsidy to reduce broadband costs.

UC is a trusted institution within the state and could serve an important role in raising awareness of existing subsidy programs through tailored messaging to reach faculty, staff, students, and the broader community. The Broadband for All program offers a comprehensive list of subsidy programs searchable by ZIP code.[63] At the campus-level, IT departments could help to increase uptake of these subsidy programs through direct communication and outreach to their campus. Undergraduate financial aid offer letters provide another potential touchpoint for UC. In addition to notifying students about their eligibility for financial aid, UC could include information about available federal broadband subsidies such as the Affordable Connectivity Program. UC already includes such messaging for food assistance programs, such as CalFresh, which received funding support of $650,000 in the 2020-2021 state budget through Assembly Bill (AB) 85 to support UC's efforts in enrolling eligible students.[64] Additional funds should be earmarked in the state budget allocation to UC to support efforts to expand enrollment in state and federal broadband subsidy programs.

Existing pre-college programming and 4-H youth activities led by UC ANR also provide an opportunity for education about available subsidy programs.[65] The UC system administers multiple pre-college programs to encourage college readiness and access throughout the state through campus-level programming and initiatives led by the Office of the President and UC ANR. Currently, pre-college programming focuses on the availability of institutional, state, and federal

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[60] "Broadband Action Plan 2020: California Broadband for All," California Broadband Council, 2020, https://broadbandcouncil.ca.gov/wp-content/uploads/sites/68/2020/12/BB4All-Action-Plan-Final.pdf.
[61] "Broadband Adoption Gap Analysis," California Public Utilities Commission, June 2019, https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpucwebsite/content/utilitiesindustries/communications/reports_and_presentations/cdvideobb/bagapanalysis.pdf.
[62] "Affordable Connectivity Program," *Federal Communications Commission,* accessed March 13, 2022, https://www.fcc.gov/acp.
[63] California For All - Broadband for All, "Affordable Service Programs," accessed April 26, 2022, https://broadbandforall.cdt.ca.gov/affordable-service-programs/.
[64] University of California, "CalFresh Legislative Report," 2020-2021, https://www.ucop.edu/operating-budget/_files/legreports/2021-22/calfresh_legrpt_2021.pdf.
[65] More than 100,000 students ages 5-19 were enrolled in 4-H Youth Development Programs through UC ANR in 2019-2020. See the Annual Report at https://ucanr.edu/sites/UC4-H/files/339098.pdf.

financial aid in order to further UC's messaging on college affordability. However, UC could expand this messaging to provide prospective college students with information on additional public support available to them.

Before undertaking new communications campaigns, university leaders should ensure that they are adequately staffed to address questions and field complaints, should they arise. They should also partner with local organizations to ensure that materials are written in locally accessible languages and convey the information with cultural sensitivity.

Partnerships

Partnerships across government, industry, nonprofit organizations, and philanthropy will be key to UC's efforts to expand broadband access to its surrounding communities. Officials at the local and state level will have a vested interest in working with UC to extend services to the constituents they serve throughout the state. These offices could be at the local level (e.g., city mayors and councils) or statewide, such as the California Department of Technology (which oversees the California Broadband Council), the Departments of Education and Health & Human Services, the Public Utilities Commission, the California Emerging Technology Fund, and others. Broadband access has also been identified as vital infrastructure for economic development by both the California Governor's Office of Business and Economic Development and the Department of Food and Agriculture. Private philanthropy, including independent foundations and community foundations with programs to support educational initiatives, could also play a role in supporting these efforts through funding proof-of-concept projects and pilot models, and with the provision of one-time funds for projects that are not covered by state or federal funding sources.

UC could also build on industry relationships established at the campus level or systemwide. UC spends millions of dollars in contracts with technology companies as vendors for software, hardware, cybersecurity, and other services. An innovative consortium could be developed to enhance outreach for digital literacy and broadband access, in conjunction with projects related to research and teaching, the core mission of the university. One promising recent example is the investment by Amazon Web Services to create the Cloud Innovation Center (CIC) at UC Davis Health; the CIC will use digital tools to make healthcare more accessible and improve platforms for health research and entrepreneurship. The center will be physically located at Aggie Square in Sacramento, a development led by UC Davis to create 1.1 million square feet of office space and clinical care facilities. Programs through Aggie Square, CIC, and the Digital CoLab will bring together researchers, clinicians, students and the surrounding community to reduce health disparities and improve care through telehealth and on-site services.[66]

[66] Katie Herritage, "UC Davis and AWS announce first Cloud Innovation Center at an academic medical center," *Amazon Web Services,* Nov. 29, 2021, https://aws.amazon.com/blogs/publicsector/uc-davis-health-aws-announce-first-cloud-innovation-center-at-academic-medical-center/.

Additional examples for engaging students include Cisco's Network Management and Operations Lab hosted at UC Santa Cruz from 2007 to 2017, and expanded to UC Davis in 2011.[67] Students were assigned to work on specific projects posed by Cisco; they received on-campus training then spent summer internships on-site at Cisco's headquarters in San Jose.[68] Although this program is now dormant, similar programs could be replicated elsewhere with UCs and CSUs to bolster the workforce needed to support broadband infrastructure.

UC campuses and systemwide offices have an opportunity to serve as regional leaders in this effort. Using its leverage as a convenor, UC can facilitate regional collaborative projects. For example, UC ANR facilitated more than 3,000 local partnerships through approximately 560 affiliated Agricultural Experiment Stations throughout the state in 2019.[69] By building on existing partnerships with community-based organizations, local government entities, and other educational institutions, UC could form regional collaboratives for broadband access that would complement current state efforts funded in 2021 to establish regional K-16 educational collaboratives.[70] These efforts could also be strengthened with private sector partnerships, such as those implemented by the Governor's Office, which partnered with private philanthropic and business partners to provide devices for 70,000 K-12 students and broadband access to hundreds of thousands more.[71]

UC could be an extremely valuable partner in expanding innovative digital inclusion efforts, such as the pilot model being developed in San Diego to other federally designated Promise Zones throughout the state. Sacramento and Los Angeles are home to federal Promise Zones where high-poverty communities would benefit from increased access to high-quality broadband. By engaging with these entities, UC would gain preference for competitive federal programs, technical assistance, and tax incentives via Congressional action through 2024 as these areas maintain their 10-year designation.[72] For campuses with significant research funded by federal entities such as the National Science Foundation, there could be a financial incentive to further this work by improving evaluation on "broader impacts" criteria.[73]

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[67] "UCSC-Cisco partnership in Network Management and Operations expands to UC Davis," *CITRIS and the Banatao Institute*, Sept. 21, 2011, https://citris-uc.org/ucsc-cisco-partnership-in-network-management-and-operations-expands-to-uc-davis/.
[68] Bob Brown, "Cisco getting cozy with UC Santa Cruz," *Network World,* April 17, 2009, https://www.networkworld.com/article/2267635/cisco-getting-cozy-with-uc-santa-cruz.html.
[69] University of California, "Annual Accountability Report 2020," https://accountability.universityofcalifornia.edu/2021/documents/pdfs/acct-2020.pdf.
[70] "Fresno K-16 Collaborative," California Governor's Council for Postsecondary Education, https://postsecondarycouncil.ca.gov/initiatives/fresno-k-16-collaborative/.
[71] "Governor Newsom announces cross-sector partnerships to support distance learning and bridge the digital divide," press release, April 20, 2020. https://www.gov.ca.gov/2020/04/20/governor-newsom-announces-cross-sector-partnerships-to-support-distance-learning-and-bridge-the-digital-divide/
[72] "California's Promise Zones," California Governor's Office of Business and Economic Development (GOBiz), https://opzones.ca.gov/resources-best-practices/california-promise-zones/.
[73] Ramesh Rao, interview by author, January 28, 2022.

CONCLUSION AND RECOMMENDATIONS

Because of its extensive geographic footprint, vast infrastructure, technical capacity, and deep ties to surrounding communities, UC is well positioned to serve a catalyzing role in the expansion of affordable and high-quality broadband access throughout the state. In response to the COVID-19 pandemic, billions in federal and state funding have been made available to support broadband infrastructure and adoption efforts, and UC should be considered a key partner in these efforts.[74] We suggest UC consider the following recommendations to leverage its unique capabilities to help the state of California close the digital divide and, at the same time, support its mission to provide world-renowned teaching, path-breaking research, and meaningful public service.

1. Infrastructure

For UC to support broadband inclusion efforts effectively, it must take stock of its infrastructure, identify opportunities for expansion and deployment of innovative networking technologies, and streamline infrastructure policies.

a. Create an inventory of existing University of California facilities and infrastructure, identify under-utilized infrastructure that overlaps with high-need areas of the state, and explore feasibility of innovative networking technologies (e.g., wireless mesh networks).
b. Engage with the legislature and UC government relations officials to request state funds for pilot programs using UC facilities to expand cyberinfrastructure, including funding to support the testing of innovative networking technologies.
c. Craft system-wide guidance on best practices in infrastructure policies, such as the leasing of UC facilities and equipment to ISPs and possible revenue-sharing models and policies that encourage investment in optical fiber in new construction projects.

2. Services & Programs

UC should identify effective strategies to expand and strengthen services for faculty, staff, and students, as well as the broader communities it serves throughout the state, to enhance provision of telehealth care, online education and workforce development, research, and public safety.

a. Work with UCOP leadership, such as VP for Research and Innovation and VP for Graduate and Undergraduate Affairs, to identify areas of collaboration to expand

[74] President Biden's Bipartisan Infrastructure Law. The White House, accessed April 18, 2022, https://www.whitehouse.gov/bipartisan-infrastructure-law/#internetaccess.

broadband capacity for research, especially as it relates to telehealth, online education and workforce development, and public safety.

b. Explore possible areas for research grant awards, such as the UC Multicampus Research Programs and Initiatives (MRPI).[75]
c. Further develop relationships and identify ways to expand work with Caltrans, CalOES, CAL FIRE and other state agencies to integrate broadband infrastructure with upgrades and new programs in service of public safety.

3. Outreach & Communications

UC can serve an important role in understanding the broadband access barriers and needs of its faculty, staff, and students and the broader communities it serves and in increasing public awareness of and enrollment in broadband subsidy programs.

a. Evaluate broadband access and affordability for UC faculty, staff and students, and the broader communities they serve. With appropriate leadership, this assessment could be conducted jointly among these constituents.
b. Raise awareness of existing subsidies (e.g., Affordable Connectivity Program) and consider offering stipends or otherwise underwriting broadband access to facilitate remote work and learning. To do so, UCOP and campus communications leaders could develop outreach materials, including a social media campaign, to alert UC faculty, staff, and students about subsidies and programs available to them and their families.
c. To support the broader community, UC should consider launching a "Connect California Corps," perhaps in partnership with the new #CaliforniansForAll College Corps program or with CITRIS's Workforce Innovation Program, to train and deploy student interns into communities and organizations throughout the state to support digital literacy, infrastructure development, and administrative tasks, such as how to apply to broadband subsidy programs.

4. Partnerships

Partnerships within the UC system and with external stakeholders, such as government, industry, nonprofits, and philanthropy, will be key to UC's successful efforts to expand broadband access.

a. Create a UC-led multi-stakeholder working group or community of practice (similar to the multi-campus working group on Responsible AI)[76] composed of CIOs, CTOs,

[75] "Multicampus Research Programs and Initiatives," University of California Research Initiatives, accessed April 14, 2022, https://www.ucop.edu/research-initiatives/programs/mrpi/index.html.
[76] "UC Presidential Working Group on AI," University of California Office of the President, accessed April 14, 2022,

CISOs, government and community relations directors, procurement officials and others to develop holistic and effective broadband policies and procedures.

b. Partner with campuses in the CSU system, California community colleges, and Tribal nations, along with CENIC and ISPs to extend last-mile access. Consider facilitating workshops or bootcamps with student and community groups to provide training in innovative network technologies.[77]
c. Create partnerships with the private sector and public entities to facilitate research and collaborative infrastructure investments to support broadband development and equitable use in service provision (e.g., telehealth), online education and workforce development, research, and public safety (e.g., wildfire monitoring, earthquake early warning).
d. Identify current staff or create new position(s) within the CIO's office to lead relationships with industry and government partners and private philanthropists, and to respond quickly when appropriate RFPs are issued to enhance this work.

https://www.ucop.edu/ethics-compliance-audit-services/compliance/presidential-working-group-on-artificial-intelligence.html.

[77] "Building connections and capacity in Indian country at the first Tribal wireless bootcamp," Community Networks, a project of the Institute for Local Self-Reliance, Sept. 21, 2021, https://muninetworks.org/content/building-connections-and-capacity-indian-country-first-tribal-wireless-bootcamp.

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Van Williams, Chief Information Officer and Vice President for Information Technology Services, UC Office of the President

Gabriel Youtsey, Chief Innovation Officer, UC Agriculture and Natural Resources

Interviews

Scott Adams, Deputy Director for Broadband and Digital Literacy, California Department of Technology, February 2 and March 22, 2022

Tom Andriola, Vice Chancellor of Information Technology and Data, UC Irvine, March 11, 2022

Louis Fox, President and CEO of the Corporation for Education Network Initiatives in California (CENIC), January 25 and March 7, 2022

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ABOUT THE CITRIS POLICY LAB

The CITRIS Policy Lab is a sub-organization of the Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS), headquartered on the UC Berkeley campus. Founded in 2001, CITRIS leverages expertise on the campuses of UC Berkeley, UC Davis, UC Merced, and UC Santa Cruz to develop technology applications with societal and economic benefits. The CITRIS Policy Lab was established in 2018 to support interdisciplinary technology policy research analyzing technology capabilities and their implications for society. Through its collaboration with public and private sector stakeholders, the CITRIS Policy Lab addresses core questions regarding the role of formal and informal regulation in promoting innovation and amplifying its positive effects on society.