Next-Gen Fixed Wireless — California Digital Divide Deployment Example and Comparison with Fiber

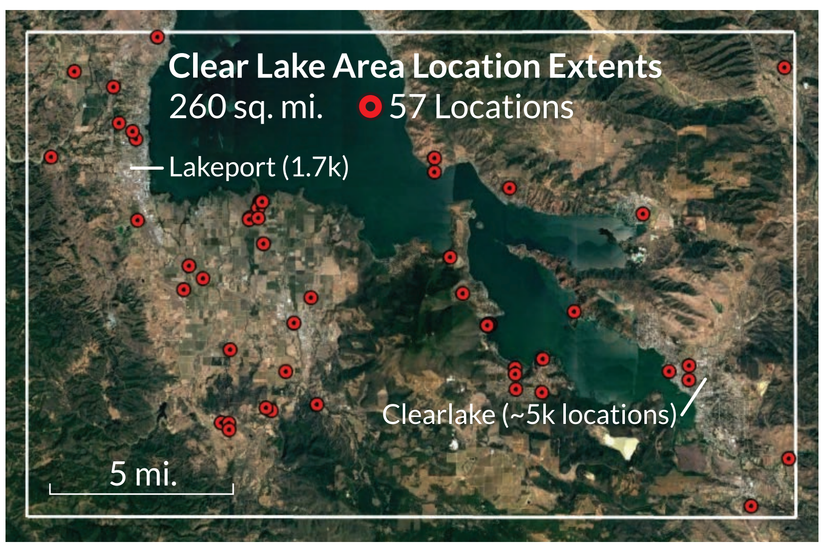
Introduction

In our October '23 paper[1] on the value of tech diversity in addressing California's digital divide, we introduced a summary profile of next-generation fixed wireless access (ngFWA) network economics and performance in live networks across a wide range of geographies and service objectives. Given the scope and intent of that piece, its ngFWA profile was necessarily brief and generalized. We've assembled this companion piece to expand on that introduction and illustrate in more detail what ngFWA can accomplish specifically in California digital divide contexts.

We tap stats from a live network built and now operated by DigitalPath (a leading wireless internet service provider in northern California) in the Clear Lake area that lies ~100 miles north of San Francisco. With 57 locations currently served across a 260 square mile area, it is a good example of the kind of low-subscriber-density challenges the state faces in closing its digital divide.

We also take a closer look at the costs of fiber in deployments with metrics similar to this Clear Lake area example, by constructing (virtually) the minimum route plan that would be required to reach all of DigitalPath's subscribers there with a new fiber build. This provides a very relevant and concrete illustration of the costs of fiber in serving locations in the low-density circumstances common to digital-divide projects in California. This profile concludes with a cost and time-to-service comparison between ngFWA and fiber in this application. **In this case fiber would be more than 20x more costly than ngFWA, and would take 6 to 17x longer to deploy** (depending on trenching crew availability). The following material explains step-by-step the derivation of these results.

Clear Lake, California — Context of Locations to Serve



The 57 locations currently served by DigitalPath in the Clear Lake area of California span 260 square miles. In elevation they vary from ~1,300 ft. (lakefront level) to 1,600 ft. All but a few are outside of the two largest population centers in the area (Clearlake, with ~5k total locations, and Lakeport, with ~1.7k).

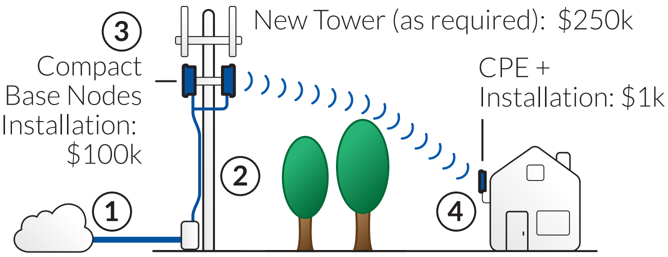
The primarily edge-of-civilization locations and inferred subscriber motivations — i.e. seeking better (or any!) broadband — of those who have signed up for DigitalPath service since its launch earlier in 2023 suggest their circumstances conform to those of typical un- and underserved California households. Worthy of note: of the 57 locations, 26% have signed up for 50 Mbps plans, 32% 100, 5% 200, and 37% 400 Mbps.

While DigitalPath did not use public digital-divide funds for this specific project, we believe its inherent low-density, high-service-level-demanded characteristics are ideal for comparison of ngFWA and fiber in a divide-project context.

Broadband Deployment Models and Installation Costs

ngFWA

Delivering fiber-class broadband service with ngFWA requires four simple elements in the field. From left to right, these are **(1)** fiber backhaul to **(2)** an existing “vertical asset” — most often a cell tower but in rural environments grain elevators, water towers, et al. are also regularly used — or a new tower where necessary — and on each of these are installed **(3)** usually four compact base nodes (BNs), with their number dependent on the degrees of radial coverage required. The BNs can communicate with up to 200 locations each. Finally, **(4)** a very smart radio at the served location (our “CPE”, dubbed a remote node, or RN) is installed at each location, sporting the ability to participate with the BN over a symmetric link budget to exchange hundreds of Mbps speeds (heading to Gbps in early 2024) despite obstructions and interference in the path.



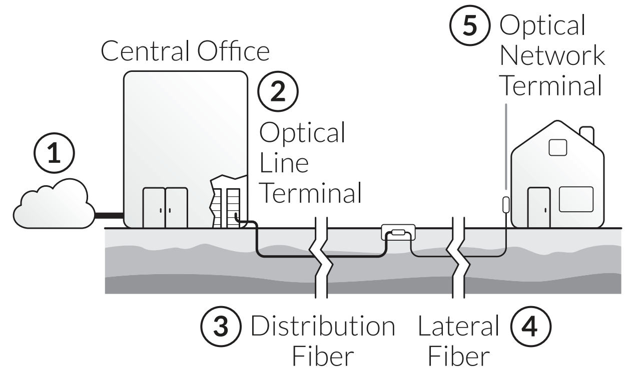
Deployment of elements 3 and 4 is very straightforward. A tower can be outfitted with BNs in 2 or 3 days of on-site work, with a total cost of hardware, BNs, and labor on the order of $100k per tower. The installation of the RN at the home is typically a couple of person-hours — with most of that time spent running an Ethernet cable from the outdoor unit into the home. RN hardware and installation are typically in the range of $1k.

Fiber

Broadband over fiber requires **(1)** central office connectivity to an internet exchange point (IXP) upstream, to connect the ISP’s users to the Internet, **(2)** an optical line terminal card in a rack-mounted access platform that provides the laser interfaces to multiple fibers headed for the target neighborhoods and locations, **(3)** middle-distance distribution fiber that carries the laser’s light to splitter boxes which (as the name suggests) route the light through **(4)** split-off lateral fiber lengths which go the final distance to **(5)** an optical network terminal (ONT) at the location to be served. The ONT converts light into standard Ethernet protocol for use by a router at the served location.

The cost of last-mile fiber varies significantly as a function of target location density (the primary factor) and other variables such as underground conditions, costs of traffic abatement, crews, etc.

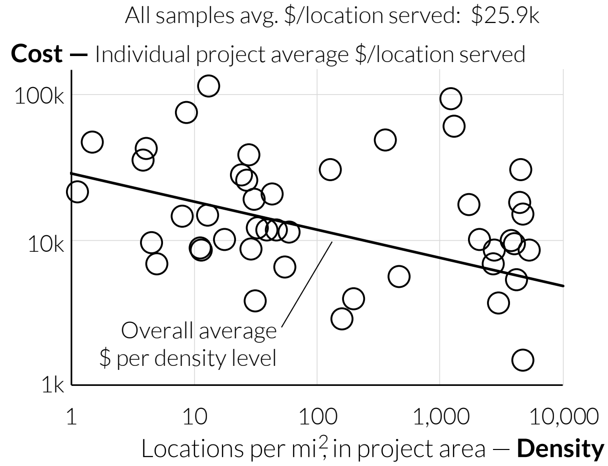
For the 46 fiber projects funded by the California Advanced Services Fund in 2019–2022, the average cost per location served was $25.9k, which corrected for Covid-era and recent inflation would be ~$40k per location in 2024 dollars.



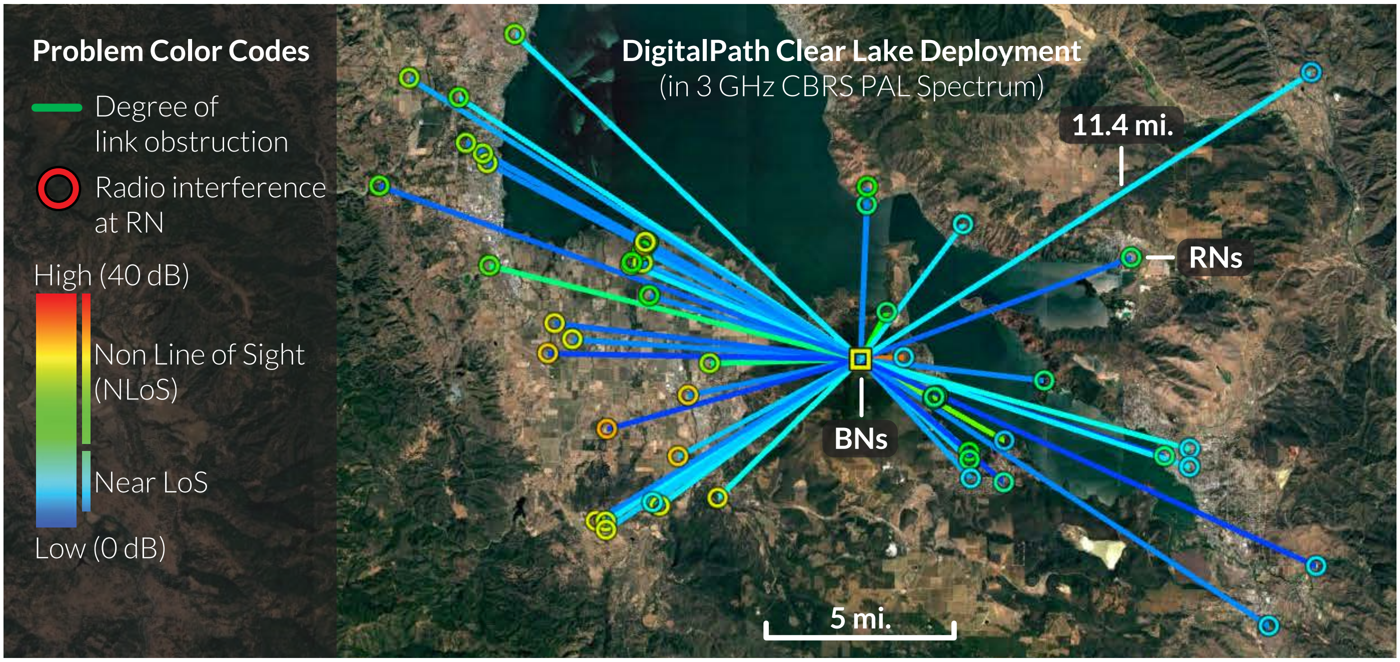
Fiber Costs Profile in California Digital-Divide Deployments

Sources: 46 state-funded fiber broadband projects, 2019-2022

All samples avg. $/location served: $25.9k



ngFWA in Clear Lake



Six months in, with ~$160k of capital investment (including RNs and their installation), DigitalPath's network is now serving 57 customers across a 22-mile span (northwest to southeast), with many links powering through interference and obstructions that would make prior FWA technologies fail. Here are the highlights:

Link Capacities (Mbps) [a]		
Downlink	Max	570
	Min	265
	Avg.	500
Uplink	Max	143
	Min	66
	Avg.	132

Link Length (mi.)	
Max	11.4
Min	0.9
Avg	5.5

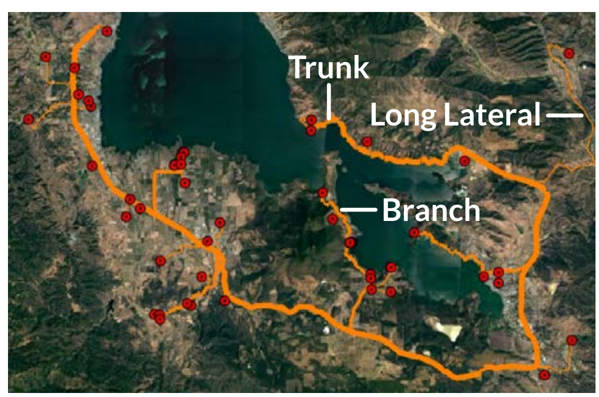
Link Challenges (dB)	**avg.**	**max**
Excess pathloss [b]	7.9	31.0
Interference/noise (@RN)	15.5	38.4

[a] these speeds are competitive with current GPON fiber installations today and will double with 2024 developments in ngFWA tech

[b] degree of obstruction (≥20 dB is NLoS)

Fiber Costs in Clear Lake

Our mock-up of a fiber deployment to serve the 57 DigitalPath subscribers, for sake of comparative cost estimation, starts with a main trunk deployment along the major highways that circle the lake (the thickest line at right). Four branches from the trunk (the mid-width lines) are added to reach small clusters of locations where individual laterals to each location would be inefficient. The third category is "long laterals" (the thinnest lines), where the trenching distance from trunk or branch to a single location was material and worth measuring. The last category was short laterals (< 200 ft.) that were not measured individually, for analysis efficiency's sake.



Adding measurements of all the fiber elements and applying an industry benchmark for rural trenching costs per mile yields a total cost for the trenching in this project of $6.8M, or $120k per location. Trenching alone for the all-fiber approach is more than 40x the cost of the complete DigitalPath deployment.

Fiber role	qty	∑ mi
main trunk	1	43.0
branches	4	19.9
long laterals	28	33.9
short laterals	28	1.1
total miles		97.8

Total trenching cost		
$k / mile	70	[2]
$k / project	6,847	
$k / location	120	

Time to Service

The final consideration is the time required to install fiber vs. the relative speed of ngFWA. Because it's possible to operate more than one trenching crew at a time, the elapsed time for trenching depends in part on crew availability. Given the broad industry concern that the large uptick in funds flowing into digital-divide projects will create more demand than can be supplied by the telecom construction sector (trenching requires specialized skills and experience to achieve reliable success, which makes it difficult to ramp capacity quickly), it's reasonable to expect low crew availability for the kind of relatively low-impact but high-cost project under consideration here — so we'd venture that two crews is a reasonable expectation. With that assumption, the project will take 9x as long as the ngFWA approach — 4.4 years to full service, in comparison to 6 months.

Fiber Deployment Time Profile				
planning and permits etc.	0.5	years		
miles of fiber deployment	98	miles		
trenching rate (per Americom Tech) [3]	0.25	miles/crew-week		
crew weeks	392			
crew count		1	2	3
years to complete trenching		7.8	3.9	2.6
years to service		8.3	4.4	3.1
time multiple of 6 mo. DP build		17	9	6

In Conclusion

The real-world example of ngFWA at work in DigitalPath's Clear Lake deployment reinforces the perspective we've taken in our *Tech Diversity Value in California Digital Divide Projects* paper[1] — i.e. that fiber is an excellent solution for higher-density applications, and ngFWA is an equally excellent tool for closing the divide where lower density makes fiber economics challenging. The additional takeaway here is the materially faster deployment speed of ngFWA — something we expect ISPs and government leaders in the digital divide context to embrace with enthusiasm, given that further unnecessary delays in closing the divide will continue to leave far too many families behind.

Please visit taranawireless.com for more information on ngFWA and its first incarnation on our G1 platform.

End Notes

[1] See *Tech Diversity Value in California Digital Divide Projects,* published by Tarana in October, 2023. Available at https://www.taranawireless.com/CA-DD-tech-diversity

[2] See https://dgtlinfra.com/fiber-optic-network-construction-process-costs — they report a range from $60k to $80k per mile, of which we used the average. This is reasonably consistent with the $k per mile extracted from the data behind the California projects' regression model on page 2 here.

[3] Stats on fiber trenching pace are not shared widely by industry participants, as it's one of the Achilles heels of the technology, and it can vary widely by terrain, the geology of what's beneath the surface, and the challenges of working around existing buried infrastructure. One construction company, Americom Technology, notes that their microtrenching approach — which is not appropriate outside of urban areas — achieves a pace of 820 feet per day per crew, which is "three times quicker than traditional trenching" (see https://americomtech.com/pros-and-cons-microtrenching). Hence our round figure of 0.25 miles per crew-week in our fiber-build timeline estimation here.

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