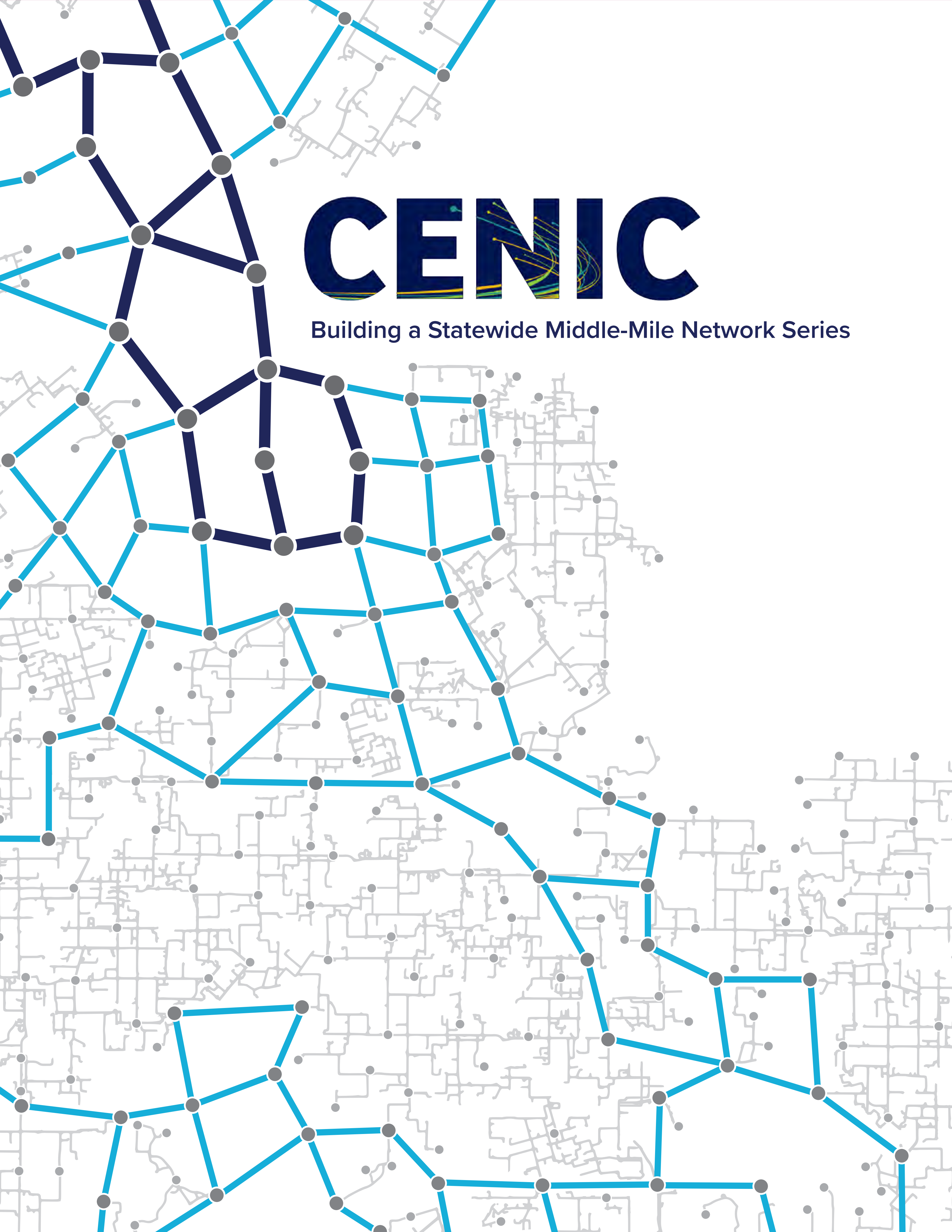
CENIC

Building a Statewide Middle-Mile Network Series



CENIC

Building a Statewide Middle-Mile Network Series

CENIC releases its ongoing Middle-Mile Network Series, addressing what middle-mile networks are, what they will do for last-mile networks and their customers, and how public and private networks will work together in one of the most geographically and socially diverse states in the nation.

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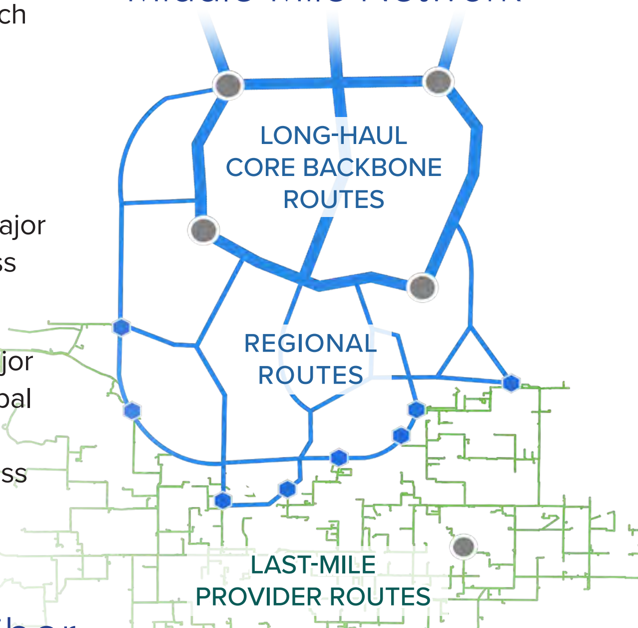
Middle-Mile Networks: What and Why

The level of interconnection necessary for the Internet to function would be impossible if billions of users had to be individually connected to each other as well as to millions of sources of content.

Achieving this interconnection implies a different approach, that of a middle-mile network consisting of long-haul core backbone routes and regional routes, and last-mile providers – not unlike the transportation model of high-capacity long-haul interstate highways that connect to major boulevards and traffic arteries, which then feed traffic into local business parks and residential streets.

In this model, an open-access middle-mile network plays the role of major highways and regional boulevards – bridging the gap between the global Internet and any last-mile providers that wish to connect to it, who then bridge the remaining gap to their individual local residential and business customers, as well as fire, earthquake, climate, and smart city sensors.

Middle-Mile Network



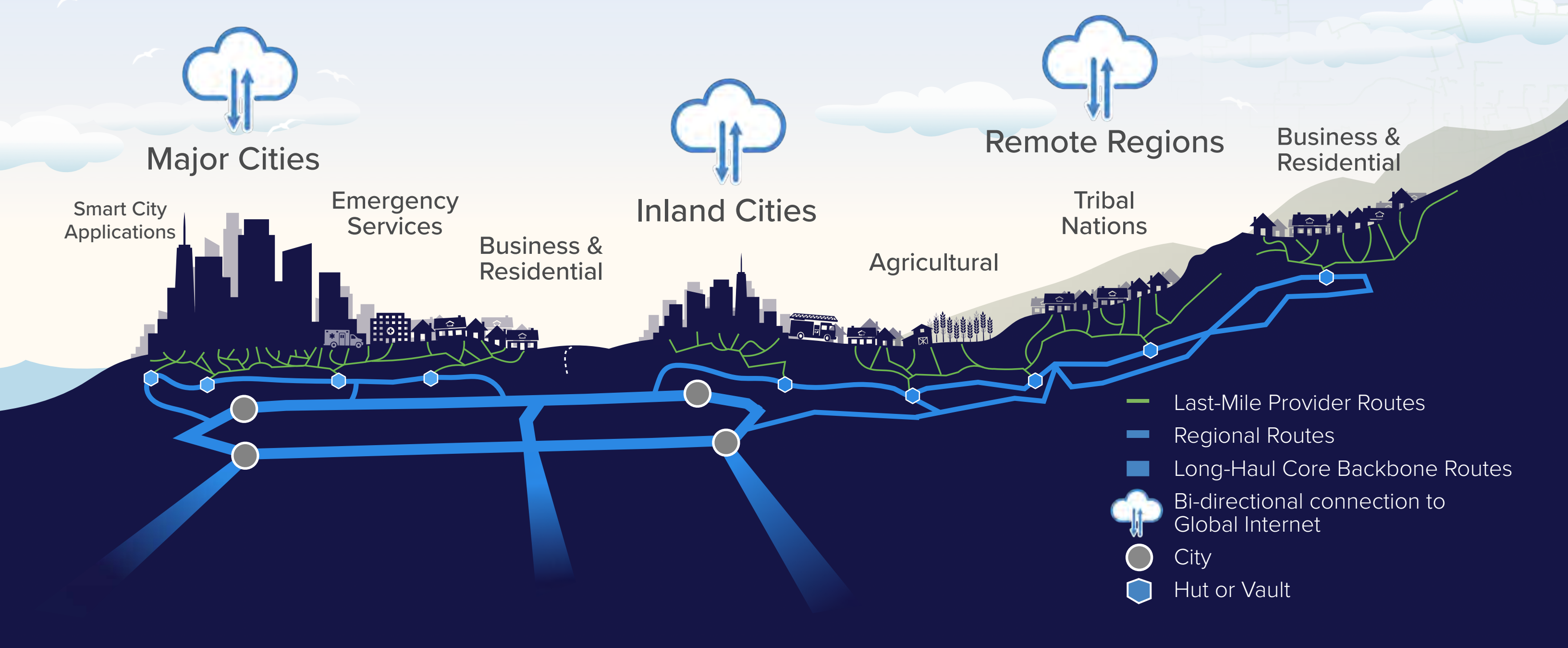
A Middle-Mile Network: More Than Just Fiber

OPERATIONS & MAINTENANCE activities are also needed to ensure the network remains up 24/7/365 – especially during emergencies when first responders will rely on it.

COMPLEX HARDWARE and software (and substantial electric power) is required to translate data into light pulses, and to send, amplify, and receive those pulses.

WIRELESS EQUIPMENT can be used to penetrate further into remote areas with special geographic challenges where installing fiber underground isn't cost-effective.

"HUTS" OR "VAULTS" are access points placed along the cable route where last-mile providers can install their own equipment to connect to the middle-mile network.



Characteristics of a Successful Middle-Mile Network

Since the purpose of an open-access middle-mile network is to bridge the gap between the global Internet at large and last-mile providers, it must consider the needs of these providers to ensure their success. This implies the following middle-mile network characteristics, which increase the attractiveness and usefulness of the network to reach even more communities, create cost savings, add resiliency, and shorten the time to service as well as ensure connections to the global Internet at the most affordable cost:

- Leverage existing infrastructure where possible and appropriate, such as IRUs on already installed fiber, existing rights-of-way, and partner resources through joint builds
- Offer a full suite of on-demand dark fiber and lit/managed services arrived at by trustworthy market research
- Design with resilient ring topologies and redundancy to ensure that spurs are only employed where absolutely necessary and never where fires, earthquakes, floods, or severe weather events can impact service
- Employ a flexible ring cut policy that permits the creation of vaults and meet-me locations where needed by last-mile Internet Service Providers

As hardware and software technology improves, *the data capacity of the exact same **fiber-optic cable** grows over time* – the very same fibers that carried 10 Gigabits per second decades ago are now carrying 400 or even 800 Gigabits per second today, and Terabit networks are on the horizon.

LONG-HAUL CORE BACKBONE ROUTES

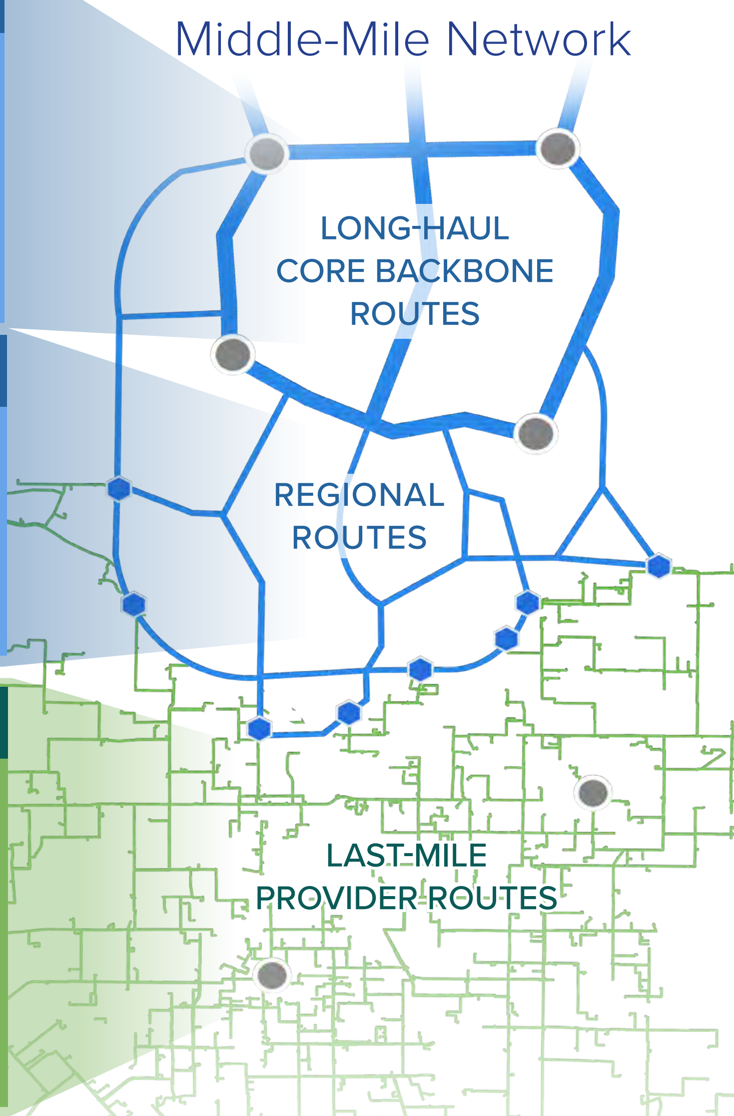
- Ultra-high-capacity, high-bandwidth routes of several hundred miles
- Reach across vast distances to interconnect widely separated regions
- Multiple resilient ring topologies an absolute must
- Connect to global Internet and content providers at major cities

REGIONAL ROUTES

- Penetrate into specific regional areas
- Provide backhaul for last-mile providers to the core backbone and global Internet
- Multiple resilient ring topologies may include occasional spur routes for last-mile provider connections or for future build-outs

LAST-MILE PROVIDER BENEFITS

- Increase and improve middle-mile services and offerings so last-mile providers may expand to more unserved/underserved areas for last-mile providers
- Provide competitive pricing for middle-mile connection services
- Alleviate the risks for last-mile providers associated with reliance on a single middle-mile provider
- Create colocation facilities that foster interconnection and growth



Build or Buy? Diverse Solutions

When designing and building a statewide middle-mile fiber-based network, one particularly important decision is whether to build a brand new long-distance fiber-optic cable route in areas where none exist, or use strands within an already installed cable via a pre-paid, discounted long-term lease called an IRU.

California presents great diversity in terms of its population centers, with densely populated urban areas as well as remote and sparsely populated. The state also presents geographic challenges like diverse terrain, weather, and natural hazards. And as you can see below, these factors influence the presence or absence of existing fiber-based middle-mile infrastructure – ample in urban areas and little to none in less populated, rugged, or remote ones.

REGION 1
NORTH COAST
- Significant areas of low population
- Tough geographical landscape
- Adjacent to multiple Tribal Nations
- Little to no access to existing fiber

REGION 1
CAPITAL AREA
- Significant areas of high population
- Lots of existing fiber

REGION 2
SF BAY AREA
- Significant areas of high population
- Lots of existing fiber

REGION 3
CENTRAL COAST
- Significant areas of low population
- Little to no access to existing fiber

REGION 4
GREATER LA
- Significant areas of high population
- Lots of existing fiber

REGION 5
GREATER SD
- Significant areas of high population
- Lots of existing fiber

REGION 1
NORTHEAST
- Significant areas of low population
- Little to no access to existing fiber

1 2 3 4 5
NETWORK BUILD REGIONS 1-5

EXISTING FIBER

REGION 2
CENTRAL VALLEY
- Significant areas of high population
- Tough geographical landscape
- Little to no access to existing fiber

REGION 3
EAST INLAND
- Significant areas of low population
- Tough geographical landscape
- Little to no access to existing fiber

REGION 5
SOUTHEAST
- Significant areas of high population
- Tough geographical landscape
- Poor to no internet access
- Little to no access to existing fiber

LEGEND

POPULATION:
Areas of high density will need greater capacity, but low density areas can include farmlands, energy fields, mines, and other areas of specialized industry with big-data needs.

GEOGRAPHY:
Challenging landscapes can make new fiber builds and maintenance difficult, and both fiber and equipment may be at risk from fires, floods, earthquakes, or severe weather events.

INFRASTRUCTURE:
Densely populated urban areas may already be surrounded by plentiful fiber, while rural or remote areas may be without fiber or Internet service of any kind.

Diverse Fiber Solutions for a Diverse State

Among other factors, this diversity in the presence or absence of existing fiber-based middle-mile infrastructure across the state comes into play when choosing from among a spectrum of "Build versus Buy" solutions. The ideal solution in one area may be very different from that implemented in another. The basic differences between building and buying are as follows:

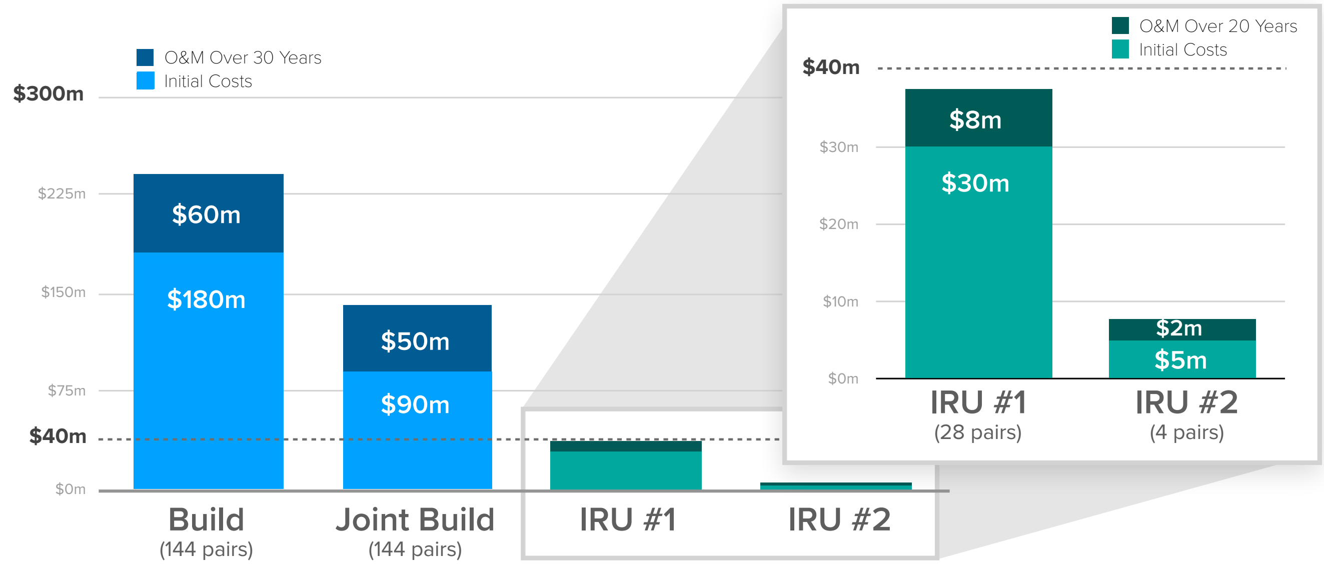
Where to Build

- Usually necessary in rural or remote areas without fiber or Internet service of any kind.
- Can involve installing hundreds or thousands of miles of new cable and significant construction work.
- Can take months or more and involve higher operations and maintenance (O&M) costs.
- Places responsibility of leasing newly installed fibers – i.e. offering our own IRUs – on middle-mile operator.
- Can include more frequent "interconnects" or locations where local last-mile providers can "tap into" the network – usually every half mile.

Where to Buy (IRU)

- Often an ideal option in dense urban areas where plentiful fiber has already been installed.
- Supports common "Dig Once" policies that seek to minimize construction cost and disruption.
- Offers a rapid "turn-up" of service, ample capacity for even densely populated areas, and lower O&M costs.
- Thanks to fixed-time lease, allows for periodic "refreshes" of fiber and equipment – and vastly increased capacity as technology improves.
- Less frequent interconnect points not an issue as last-mile providers typically connect to through established metro networks.

Comparison of Costs of Various Fiber Solutions



Estimated build/buy costs and O&M average costs to equip, run, and maintain taken from a representative California metro network design

There are multiple approaches to building and buying, including joint builds done with partners, leasing space within an underground conduit through which a new fiber cable can be pulled, leasing capacity on any number of existing fibers, from just two pairs – already more than adequate to serve even a large community – to an entire installed cable of 288 or more fibers.

Building a fiber-based middle-mile network requires careful and customized decision-making for a state as diverse as California. The ideal solution for one area may not be the same as in other areas. However, a middle-mile network has a wide range of tools at its disposal from completely new fiber builds to leasing capacity on already installed fiber that can provide ample, equitable, future-facing capacity for any community's needs across the state.

Service Product Offerings on a Middle-Mile Network

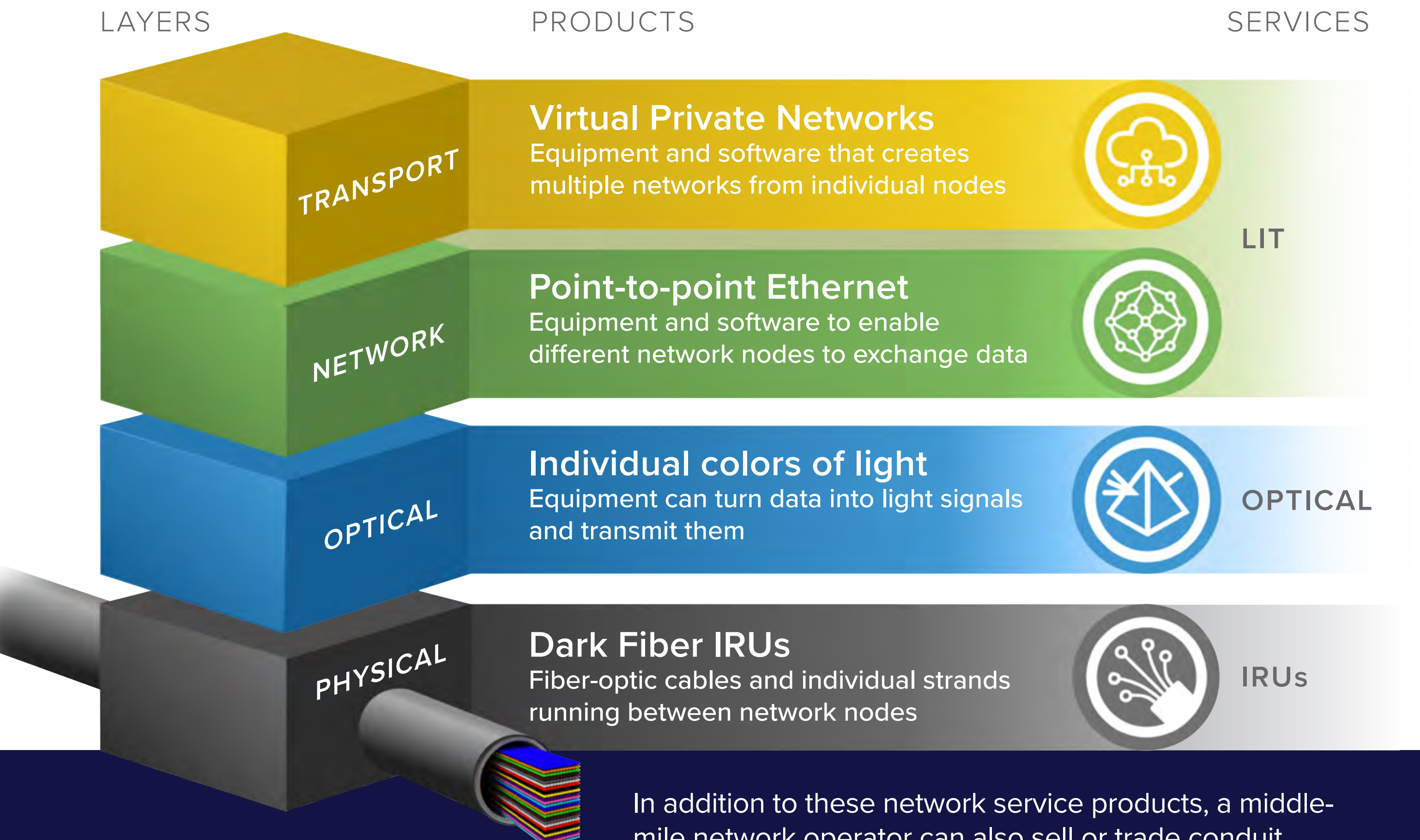
A statewide middle-mile network may consist of multiple layers of equipment and software to complete "handoffs" of data to and from last-mile providers, translate that data into light pulses sent over fiber-optic cable, and connect to the global Internet or cloud service providers like Netflix and Amazon Web Services.

However, not every last mile-provider may wish to connect to a middle-mile network in the same way. Some may require greater capacity or seek greater control over services they create themselves and provide to their customers. Others may wish to connect their end-user customers to existing services and content providers.

Thus, if a middle-mile network operator is to attract last-mile providers as customers, it must offer a broad catalog of service products to meet an equally broad variety of needs well beyond the services offered by a typical Internet Service Provider.

Multiple Layers of Equipment and Service Products

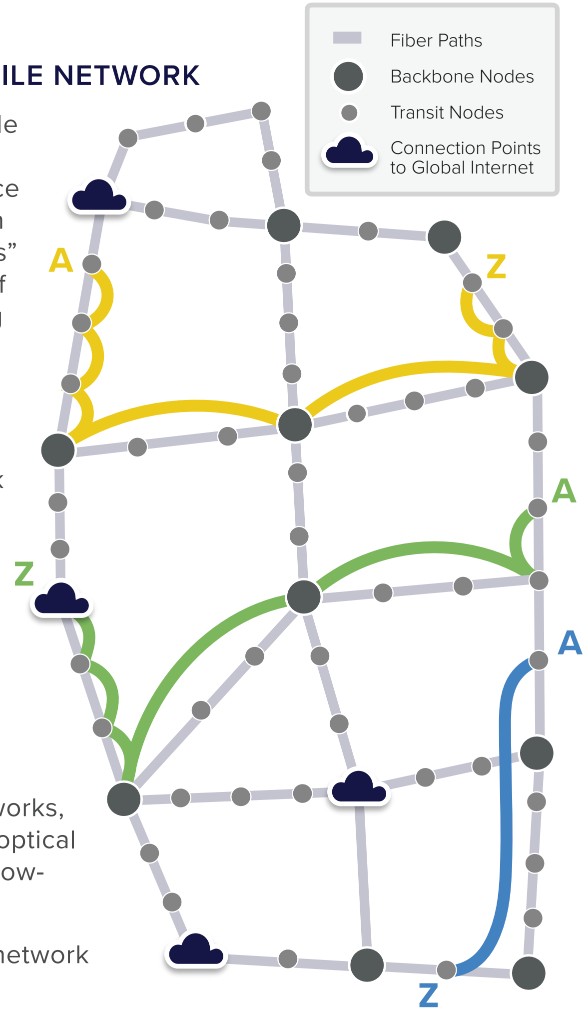
The different layers of a middle-mile network can be visualized literally from the ground up – starting with the medium over which the data travels to the equipment that sends the data and the software that governs that equipment and defines the networks that operate over it. Each layer requires the smooth, error-free operation of all layers below it, and last-mile Internet service providers may wish to purchase services at any or all of these layers from a middle-mile network operator.



In addition to these network service products, a middle-mile network operator can also sell or trade conduit space to other interested parties, rack space in network facilities (called colocation or "colo" services), and network engineering consulting services.

The Middle-Mile Network and Service Offerings

The same fiber network can function very differently depending on the network layer on which a given service product resides.



CREATING PRIVATE NETWORKS USING A MIDDLE-MILE NETWORK

Private networks residing on the Transport layer allow last-mile providers to create their own networks on the middle-mile infrastructure and connect to their own non-contiguous service areas as well as to other providers also on the network. Such connections can make use of carpool-lane like “express paths” along the backbone that enable the providers at either end of the path to connect to one another without their traffic having to transit every node between them.

CONNECTING TO THE WORLD VIA A MIDDLE-MILE NETWORK

Ethernet and cloud provider services residing on the Network layer enable last-mile providers to connect their customers to the global Internet beyond a middle-mile network. Such connections also use backbone “express paths” that enable last-mile providers to connect the customers on their own networks directly to global Internet connection points as shown – ideally, to more than one.

DARK FIBER AND OPTICAL SERVICES

Carriers can use dark fiber IRUs and optical services, such as spectrum service to add dedicated capacity to their own networks, to make their network more resilient by adding additional all-optical paths to expand their footprint, or to create customized very low-latency services of their own.

These services consist of specific paths along a middle-mile network Physical layer, with amplification where needed.

Dark Fiber and Lit Services: Resources and Revenues

While last-mile providers can purchase service products from a middle-mile network operator at all layers of the network, smaller providers may find it challenging to purchase dark fiber IRUs or optical services, since creating custom services at lower layers requires significant investments of time, money, and resources. However, the revenue potential of these services is also greater.

Purchasing a Lit Service

- Restricted in their ability to custom-configure their service for their end-user customers
- Requires less investment in equipment and expertise on their part
- Less potential for revenue
- Can be put into production much more quickly

Purchasing an IRU or Optical Services

- Can offer a more customized, higher-capacity service
- Requires greater investment in equipment and expertise to light the fiber and create/maintain their network and services
- Potential for greater revenue
- Takes more time to put the service into production

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Optical Services over Middle-Mile Networks

Many carriers and last-mile providers may be interested in purchasing out-of-the-box "lit" services from a middle-mile network, like a Virtual Private Network (VPN) or connectivity to cloud providers or the global Internet. If they wish to configure a custom service, they might choose to lease a pair of fiber-optic strands via a dark fiber IRU (a long-term lease) and light the fiber themselves, but there are other options on the Optical Layer between dark fiber and lit services: Optical Services.

Optical Services means purchasing one or more "slices" of the total spectrum of light carried by a fiber pair: a defined amount of bandwidth on either side of a central wavelength. The capacities that a carrier or last-mile provider can obtain through such services typically run into the hundreds of gigabits per second, making Optical Services equivalent to a dedicated high-performance fiber path.

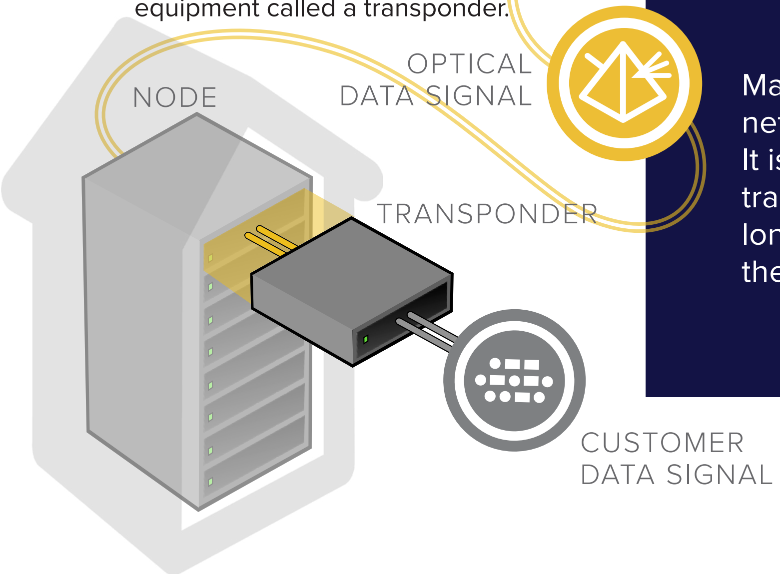
What's more, recent innovations in technology can enable smaller carriers and last-mile providers to take advantage of such services in a cost-effective manner.

How Optical Services Work

1. **CUSTOMER DATA HANDOFF**
At the Optical Layer, data signals from the last-mile provider are not modified in any way but turned directly into light pulses of a specific color (wavelength). This "transparent" data signal translation is done by a piece of equipment called a transponder.

2. **TRANSIT ALONG FIBER BACKBONE**
These light pulses are then sent down the fiber and then turned back into customer data signals when they reach the node at the other end.

3. **DATA ARRIVES AT DESTINATION**
Depending on the transponder and the width of the spectrum band, one "slice" of spectrum can support different data throughputs.



Managed Optical Services are where a middle-mile network operator owns and manages transponders. It is also possible for customers to provide their own transponders to the middle-mile network operator, as long as those transponders have been validated by the network operator.

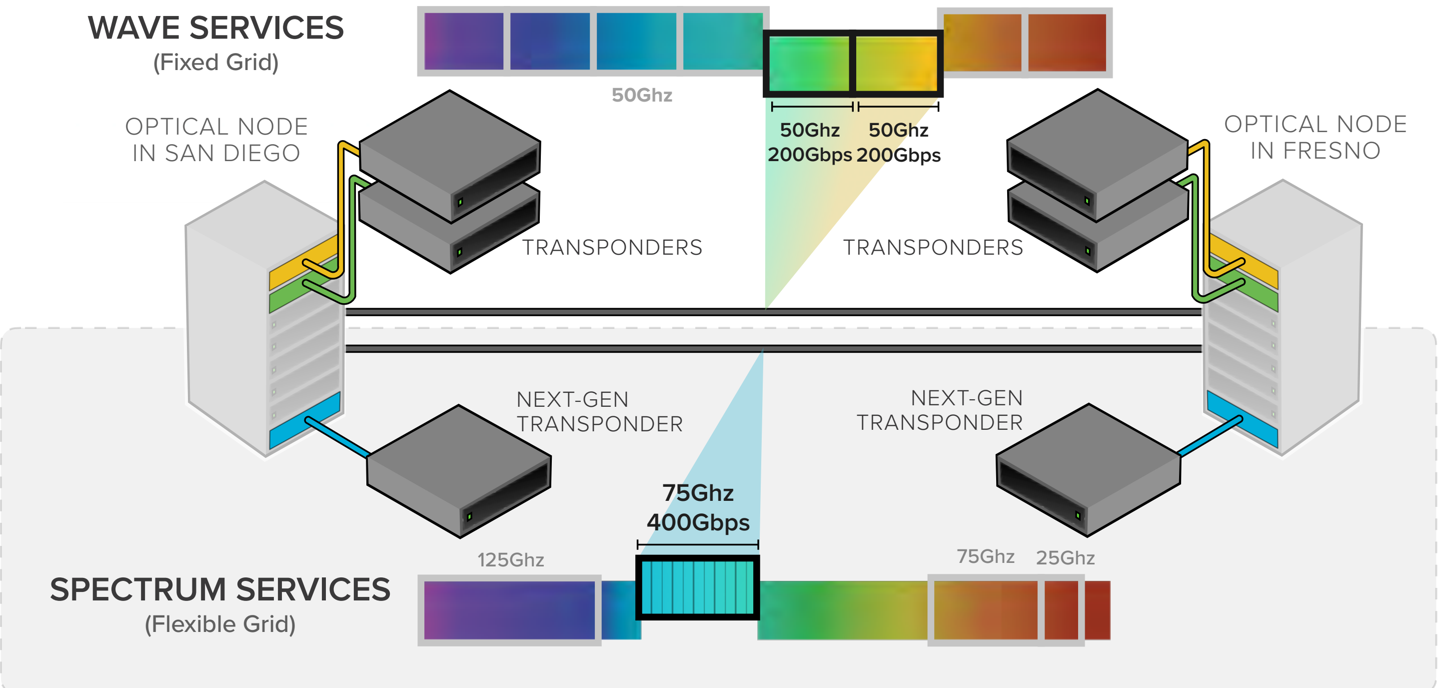
Rapid Expansion and Upgrades for Last-Mile Networks

Many carriers or last-mile providers may wish to expand their services to new locations or add capacity and resilience to their existing network via a second network path, but find this cost-prohibitive due to a lack of existing fiber infrastructure in the regions of interest. Even if a new fiber build is possible, it may simply take too long. Using Optical Services, a customer can quickly expand to a new location hundreds of miles away and appear as a single very high-capacity network, or add capacity and resilience to their existing network via a new high-performance network path.

Wave and Spectrum Services: Fixed or Flexible Grid

An Optical Services customer also enjoys a great deal of freedom in terms of the services they can provision within their purchased “slice” of spectrum, and depending on the capacity they need, their own resources, and what they wish to provide to their own customers, they can choose between two types of Optical Services: Wave and Spectrum.

For most middle-mile networks, the full 4800 GHz spectrum that a typical pair of fiber-optic strands can carry is evenly divided into a fixed grid of uniform 50 GHz-wide “slices”, and fixed-grid ***wave services*** are sold by the “slice”. Depending on the transponder that is used to turn data signals into light pulses, each 50 GHz “slice” can carry up to 200 Gbps of data traffic. To do this, each “slice” requires a transponder on each end of the fiber pair.

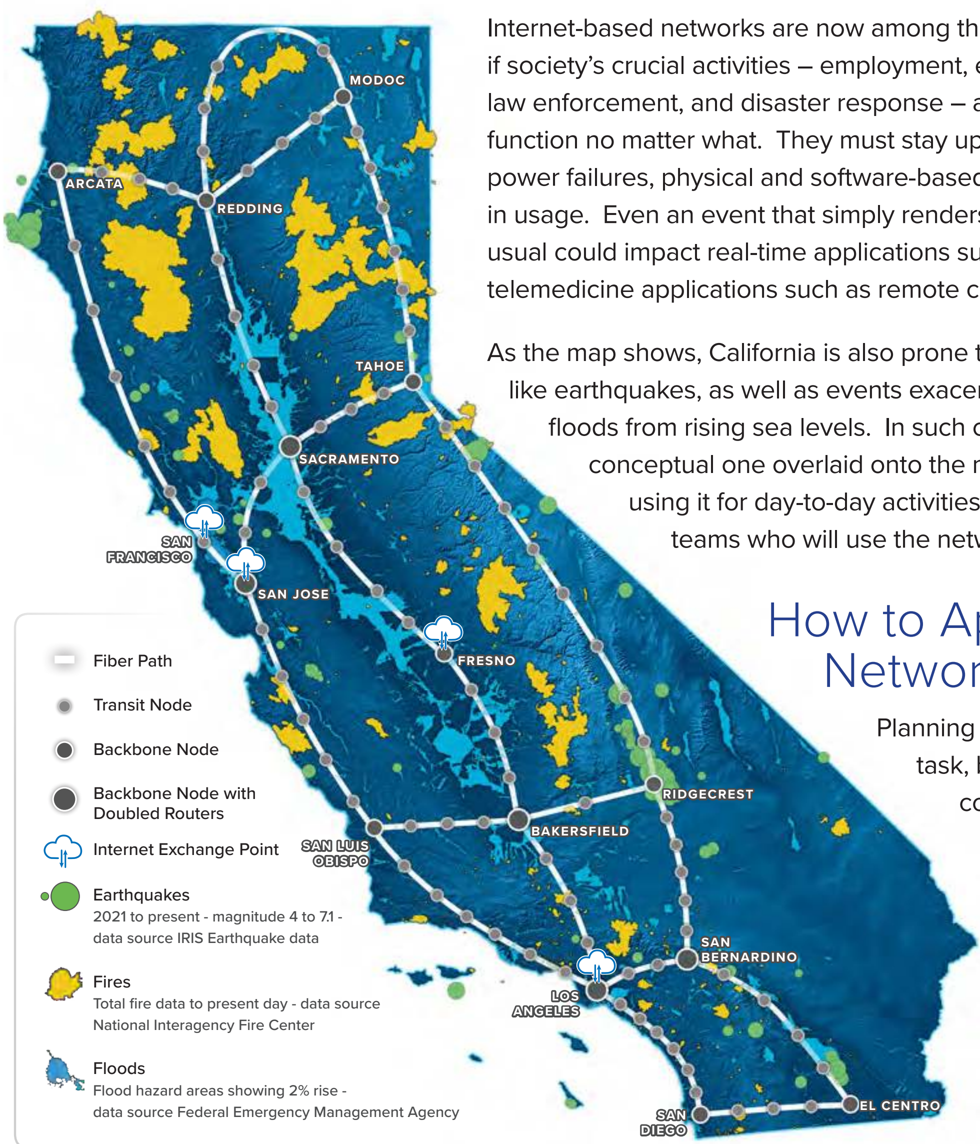


Future-facing middle-mile networks feature the ability to provide a customer’s desired capacity on a pair of fiber strands with ***spectrum services***: combining multiple much smaller “slices” (currently 6.25 or 12.5 GHz wide) into one composite “slice” of flexible size. This composite “slice” is treated as a single signal by one pair of Next-Generation Internet (NGI) transponders, which can enable considerably higher data throughputs thanks to recent innovations.

The comparison below illustrates how spectrum services can use less spectrum than wave services to provide greater capacity while also using less equipment, rack space, power, and maintenance.

Wave (Fixed Grid) Services	Spectrum (Flexible Grid) Services
To provision 400 Gbps of capacity using wave services, at least four transponders are required, a pair for each of the two 50 GHz “slices” of spectrum that must be purchased. Additionally, all four transponders require power, rack space, and ongoing maintenance costs.	To provision 400 Gbps using spectrum services, only one pair of NGI transponders are needed for 75 GHz worth of spectrum, composed of multiple much smaller “slices”. Therefore, half as much equipment is required, and thus half the rack space, power, and maintenance costs. Additionally, since NGI transponders are capable of much greater capacity than the typical 200 Gbps of most transponders, customers can reach near-Terabit data rates depending on the size of the purchased “slice” of spectrum and which NGI transponder is used.

Resilient Communities Need Resilient Networks



Internet-based networks are now among the world's foundational infrastructures, and if society's crucial activities – employment, education, commerce, healthcare, utilities, law enforcement, and disaster response – are to take place, these networks must function no matter what. They must stay up and run in the face of equipment and power failures, physical and software-based attacks, disasters, or even sudden spikes in usage. Even an event that simply renders a middle-mile network slightly slower than usual could impact real-time applications such as video meetings, online testing, or telemedicine applications such as remote consults and pacemaker monitoring.

As the map shows, California is also prone to a variety of large-scale natural events like earthquakes, as well as events exacerbated by climate change like wildfires and floods from rising sea levels. In such cases, a middle-mile infrastructure like the conceptual one overlaid onto the map must remain working not only for those using it for day-to-day activities, but also for the disaster management teams who will use the network to respond to the event.

How to Approach Resilient Network Design

Planning for network resilience is a complex task, but a network design team and their collaborators can approach it by asking the following three key questions at the bottom of the page.

This three-part approach will result in a middle-mile network that can withstand expected problems (cuts, outages, attacks, traffic spikes, etc.) and continue to support well-defined crucial applications, access, and security.

What Might Happen?

This can include natural disasters, equipment or power failures, sudden traffic spikes, and deliberate or accidental interference anywhere along the network, such as fiber cuts.

A network design team will also factor in range, likelihood, frequency, and severity.

What Activities Are Critical?

This can include functions like videoconferencing, data storage access, disaster management, and important enterprise-level activities like payroll.

The network design team and their collaborators may decide to perform industry and customer research to identify them.

What's The Budget?

The project budget and spending requirements can inform when and how much fiber, construction, software, equipment, personnel, power, etc. can be purchased.

This can also inform where partnering is preferable, which resources are most available, and which supply chains are acceptable.

Basic Guiding Principles for Resilient Design

While carrying out the above discovery and design process, a network design team and their collaborators will keep the following basic guidelines in mind as decisions are made to ensure that the network supports those who use it with the required level of performance and resilience, now and in the future.

DATA & ACTIVITIES NEED MULTIPLE PATHS

This includes network traffic as well as maintenance, power and management activities, and supply chains. This means parallel design, multiple backups, and no single points of failure.

DOCUMENTATION & PROCESS ARE KEY

Parallel design increases complexity and the potential for unforeseen network behavior in response to events. Solid documentation and well-socialized procedures mitigate this.

KEEP & REVIEW PERFORMANCE METRICS

Metrics should extend beyond network behavior to things like internal, vendor, and partner performance, so overall resilience can be studied and used to inform improvements.

The Guiding Principles in Action

When these principles are applied to middle-mile infrastructure, the end result is a network – and a society – that can function, respond, adapt, and even thrive in the face of challenges, including public safety challenges when the network is most needed while itself under threat.

FIBER PATHS AND CONNECTION POINTS

Well-designed middle-mile network topologies feature path "rings" so traffic can still flow even if a path is cut. Nearly all traffic will traverse long-haul routes and core routers, which must support high use. Regional routes also use ring topologies ideally terminating on different backbone routes, with "spurs" – routes not connecting back to the network – used rarely if at all, especially not without a separate return path (e.g. a fixed wireless path) to the network backbone to provide resilience.

NETWORK EQUIPMENT

If equipment stops functioning for any reason, standby equipment that can instantly take over is needed. Ideally this process, known as "failover," happens transparently so anyone using the network during the event will not even realize it has happened. This can mean putting two separate "doubled" routers in place at high-traffic nodes, or doubling up equipment like line cards within a single router.

These principles are applied to more than just the network. Poorly designed management, collaboration, or documentation systems can impair a middle-mile network's resilience as much as a poorly designed fiber route.

SOFTWARE FOR MANAGEMENT, CONTROL, AND MONITORING

Equipment failover, dynamic routing, and adapting to sudden high use all require complex software housed in multiple locations. Such software can also mitigate Distributed Denial of Service (DDoS) attacks, where a malicious attacker, perhaps thousands of miles away, floods a network with useless traffic to bring it to a practical halt.

ORGANIZATIONAL RESILIENCE

A middle-mile network operator itself must also be resilient, with no one person performing any vital function. In addition to clear, accessible, and thorough documentation; well-defined and socialized processes must be in place and followed to avoid bottlenecks and confusion.

VENDOR, SUPPLIER, AND PARTNER RESILIENCE

Resilience must also be built into relationships with vendors, suppliers, and other partners, such as purchasing electrical power or maintenance from providers on separate infrastructures and ensuring supply chain resilience so no equipment or service can be purchased exclusively from one supplier.

A Network of Networks: Transit, Peering, and Exchange Points

Before the commercialization of the global Internet, network pioneers such as Prodigy, AOL and CompuServe created separate, private networks. However, a customer on one of these networks could only talk to others on the same network. Over time, users wanted to communicate across networks.

As public access to the "network of networks" -- now known as the Internet -- became more prevalent, two models for connecting emerged: transit and peering.

The global Internet is composed of interconnections between tens of thousands of separate Internet Service Provider (ISP) networks, which are divided into tiers depending on their size, extent, and the amount of traffic they carry.

TIER 1

Operate vast intercontinental and trans-oceanic networks of enormous capacity which function as the Internet's global backbone.

TIER 2

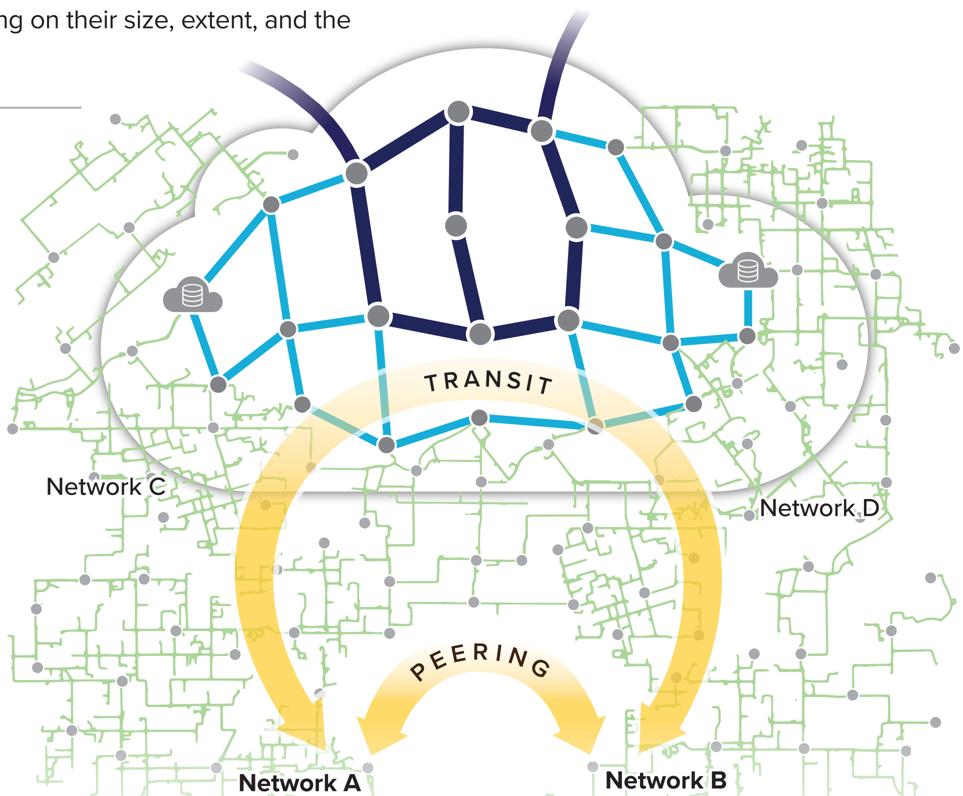
Operate national or regional networks with abundant capacity. They bridge the gap between the Tier 1 ISPs (the global Internet backbone) and Tier 3 networks.

TIER 3

Sometimes called last-mile providers, these networks provide service to homes and businesses. They serve local regions and typically connect to a middle-mile network to reach a Tier 1 ISP.

CLOUD PROVIDER

While not ISPs, major cloud providers such as Microsoft, Google, Amazon Web Services, Netflix, and Apple also manage and operate their own network infrastructure.



Networks A and B, shown here, are each connected to the Internet and can exchange traffic via ***transit*** – in other words over another network or series of networks (Networks C and D) that they both connect to, as intermediary links.

However, Networks A and B may decide to connect directly to each other and share traffic without transiting other networks – ***peering***. Peering can be paid or ***settlement-free,*** and may involve an informal understanding or a written contract.

Whether two networks engage in a peering relationship depends on many factors, including whether the networks are in the same tier, how much traffic each carries, whether they are commercial or nonprofit, or how many customers each serves. For example, CENIC pursues peering relationships with other networks including major cloud providers, allowing their data to travel directly to the millions of Californians that use CENIC's infrastructure and avoiding transit expenses and delays, vital for access to critical data and content, updates, and computing resources.

When networks provide transit, they typically charge based on traffic volume for this service. This can make traffic exchange expensive, especially since global Internet traffic continues to increase at a compounded annual rate of 30%.*

* "Internet Traffic and Capacity Remain Brisk," **TeleGeography.com** Blog, September 13, 2022.

Building a Network of Networks: Internet eXchange Points

Interconnections between networks take place at Internet eXchange Points (IXPs), extremely large facilities heavily provisioned with rack space, bandwidth, and power where the world's networks physically meet to connect to one another for mutual benefits. IXPs are the high-tech "farmers' markets" that create the vibrant, commerce-based ecosystem of network connections – transit and peering, paid and settlement-free – comprising the Internet as we know it.

In California, the largest IXPs are in Los Angeles and the San Francisco Bay Area. All major international carriers connect to each other and other networks at these facilities. The more large networks use a given IXP, the more other networks, including middle and last-mile providers, will want to use that IXP.

New Regional Internet eXchange Points: How & Why

While existing IXPs were crucial to the formation of the global Internet and remain essential, rural and remote areas are disadvantaged since even local traffic must travel back and forth to existing IXPs, and the resulting latency -- the traffic's travel time over the network -- impacts performance.

Establishing new regional IXPs can help alleviate these issues but can be challenging since a threshold number of carriers must participate before it becomes cost-effective. One way to attract carriers to a new regional IXP is for a middle-mile network operator to negotiate with large content providers to place content servers that enable the caching of high-demand content within the IXP.

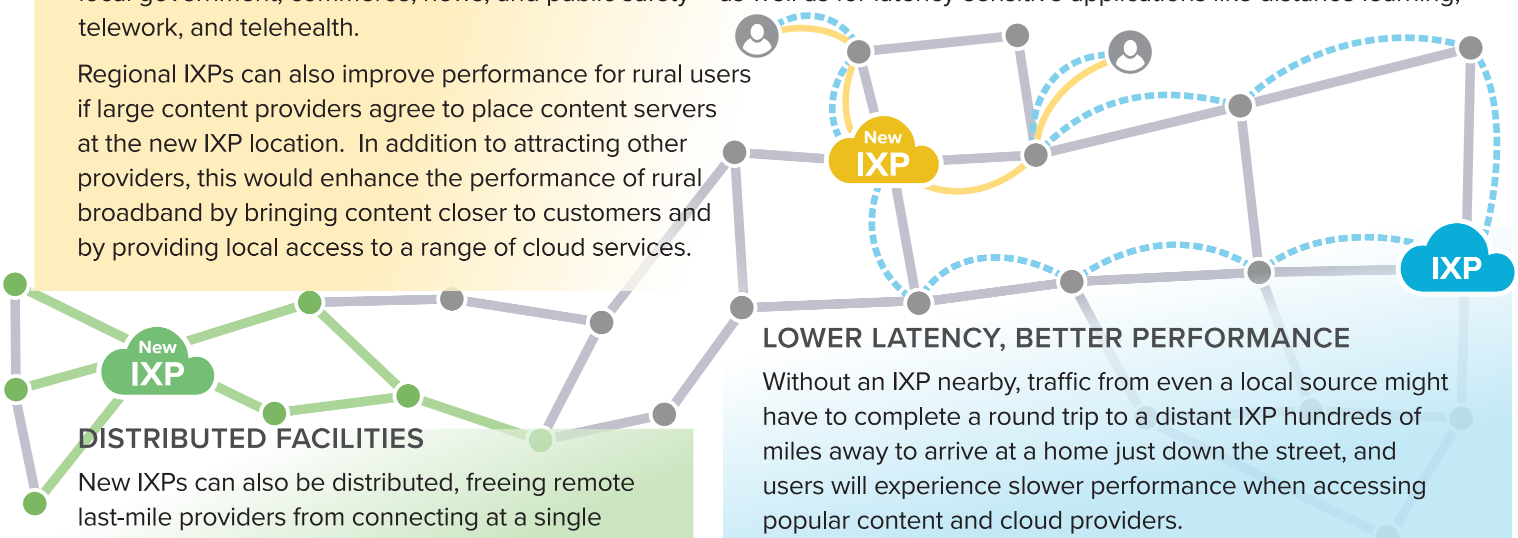
Since the major IXPs in California are all coastal, new exchange points in inland regions would improve network resilience and decrease costs of last-mile projects in these regions.

Three Major Benefits of Regional IXPs for Rural Communities

KEEPING LOCAL TRAFFIC LOCAL

With a regional IXP nearby, rural users would experience lower latency to and from local resources like school districts, local government, commerce, news, and public safety – as well as for latency-sensitive applications like distance learning, telework, and telehealth.

Regional IXPs can also improve performance for rural users if large content providers agree to place content servers at the new IXP location. In addition to attracting other providers, this would enhance the performance of rural broadband by bringing content closer to customers and by providing local access to a range of cloud services.



LOWER LATENCY, BETTER PERFORMANCE

Without an IXP nearby, traffic from even a local source might have to complete a round trip to a distant IXP hundreds of miles away to arrive at a home just down the street, and users will experience slower performance when accessing popular content and cloud providers.

DISTRIBUTED FACILITIES

New IXPs can also be distributed, freeing remote last-mile providers from connecting at a single distant facility. One example of such a distributed exchange is Pacific Wave, a project of CENIC and the Pacific Northwest Gigapop. Pacific Wave is a distributed peering facility that enables networks in East Asia, Southeast Asia, Oceania, and North America to interconnect. There are nodes for Pacific Wave interconnections in Los Angeles, Sunnyvale, Seattle, Chicago, Denver, Honolulu, Guam, and Tokyo.

By improving performance, regional IXPs could also make the middle-mile network more useful for Internet of Things (IoT) uses such as environmental sensors, transportation and logistics, and disaster warning and response.

Middle-Mile Network Access for California's Tribes

The middle-mile fiber-based network shown on the map below is the current state for infrastructure that will provide vital connections between Tribal Communities and the global Internet. The network could provide access to regional ISPs and Tribes, at capacity and speeds that will allow networks to scale to accommodate the needs of an entire community.

The route prioritizes areas that have no access to the global Internet or slow and ineffective connections which leave many households and community anchor institutions at a severe disadvantage – unable to take advantage of broadband-enabled services such as telehealth, remote work, and remote educational environments.

Resource Links

- California PUC Tribal Broadband Planning Program
- NTIA Tribal Broadband Connectivity Program
- US Department of Treasury Tribal Consults
- GoldenStateNet Initiative at CENIC.org
- FCC Office of Native Affairs and Policy
- FCC Affordable Connectivity Program
- USDA Telecom ReConnect Programs
- CENIC Middle Mile Access for Tribes
- Tribal Broadband Bootcamps
- Golden State Network Overview
- CalTrans Dig Once Policies
- CDT Broadband for All

If your Tribe's location is missing or inaccurately represented on the backbone map, please contact tribes@goldenstatenet.org as soon as possible. We seek to represent Tribal Nations within California with complete accuracy and appreciate your assistance in attaining that goal.

Network Project Implementation Timelines

In order to better prepare for participation in such a large-scale, multi-year network project, an understanding of general timelines can be very helpful. Such timelines exist for planning, funding opportunities, and network design and construction and are shown at right to provide your Tribe with a high-level awareness of the stages of participation.

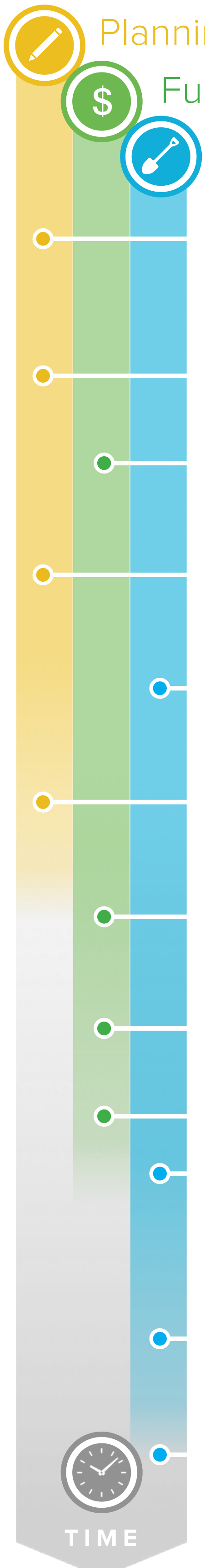
The Next Steps for Tribal Projects in California

A major goal of this project is to connect all Tribes in California to the global Internet at broadband speeds via the illustrated middle-mile infrastructure. However, the process by which this will take place will differ depending on your Tribe's location -- especially whether your Tribe is adjacent to a Caltrans Right of Way.

If your Tribe is not adjacent to a Caltrans Right of Way, please note that backbones have hundreds, if not thousands of connection points. In such cases, we will identify the most conveniently located connection point for your Tribe and help align you with the funds and other opportunities needed to connect at that point.

Tribal representatives from all of California's Tribal Nations are urged to contact Matthew Rantanen at tribes@goldenstatenet.org to learn more about participating in this project.

Scan the QR code to download this one-sheet, and access it's interactive links.



TRIBAL BROADBAND INITIATIVE
Tribal leadership adopts a communications initiative for broadband for the community (Tribal resolution)

BROADBAND STUDY
Conducted with key Tribal stakeholders

IDENTIFY FUNDING OPPORTUNITIES
Federal, State, and private funds to support broadband planning

BROADBAND FEASIBILITY STUDY
Availability of existing resources and desktop engineering

NETWORK DESIGN & ENGINEERING
Working with a firm or team to create the final connectivity plan

HISTORICAL PRESERVATION, ENVIRONMENTAL APPROVALS
Obtained from within the Tribe

FUNDING AVAILABILITY ALIGNMENT
Aligning with Federal and State funding opportunities

FUNDING APPLICATION PROCESS
Conducted with key Tribal stakeholders

ACQUISITION OF FUNDS

NETWORK BUILD IMPLEMENTATION
May include new hires, office buildout, construction team expansion or development, and the actual construction of the network

LIGHTING THE NETWORK
Making the network live, acquiring customers, and using the network

OPERATIONS & MAINTENANCE
Long-term management, expansion, and maintenance of the existing network, including customer support