HUBBELL®

NTTA

Pathways to Success: An NTTA Broadband Reference Guide

Contents

Vision

When starting down your Tribal broadband journey, it is paramount to set a solid vision. What is your reason for creating a broadband business or becoming an Internet Service Provider (ISP)? What is the purpose and what are you ultimately trying to achieve? What is your plan to reach your goal?

The Vision is the Mission

If you cannot clearly and efficiently describe the mission of your broadband project, it might struggle to start or achieve its objectives. Developing a compelling vision statement is essential for defining practical strategic goals for your broadband project.

Your vision statement should answer these key questions:

- What needs are you trying to fulfill?
- What kind of services are required to meet those needs?
- What kind of network is required to offer those services?
- What resources are required to build and operate the network?
- How will you financially start, build, and sustain the network?

Thoroughly researched answers to these questions determine whether and to what degree your broadband project will succeed. The 30-second, 90-word summary of these answers is your vision for the broadband project. A well-articulated vision entices money from various sources, and successful federal and state grant applications inspire sweat equity from stakeholders while keeping the network project team focused on what matters. The real power of a good vision statement comes from the process by which you distill a complex technology and the facets of its deployment down to 90 words or less.

Know Exactly What You Want (what are your needs?)

You must first identify the needs of your tribal community that you are trying to fulfill.

For example:

- Provide essential services on reservation (housing, healthcare, agriculture, emergency services)
- Economic development to tribal communities
- Job creation (remote offices, job searches, online start-ups)
- Educational opportunities (remote learning, improved services to schools/libraries)
- Revenue generation opportunities

If you don't know or can't coherently articulate an answer to "what do you specifically want," chances are your project faces an uphill battle to get funding or succeed if it is awarded grant monies. Telling the "story" is key, especially regarding broadband funding. Who has the clearer vision, the project that intends "to deploy a shovel-ready, sustainable, licensed microwave Middle Mile to a fixed wireless broadband Last Mile network to provide broadband services in a rural service area?" Or the project that wants to "bring fiber optic service to over 7,000 homes, 100 businesses, and 26 anchor institutions in 4 underserved Tribal reservations located in rural Oklahoma and create an expected 40 plus new jobs?"

Begin crafting what your Tribe wants by performing Stakeholder & Community Outreach along with Goal Setting. These activities will provide you with concise directions and answers you will need. Begin crafting what your Tribe wants by performing Stakeholder & Community Outreach along with Goal Setting. These activities will provide you with directions and answers you will need.

Stakeholder & Community Outreach

For a broadband project to be successful, it is essential to reach out and engage stakeholders (e.g., council, tribal government departments, decision-makers, etc.) and the community. Stakeholder and community outreach involve creating relationships with those who will benefit from the project and building support within the local area. This process ensures that all parties involved are on board with the project's objectives while also helping to identify any potential issues or concerns that may arise along the way. By doing stakeholder and community outreach, projects can increase their chances of success by fostering positive relationships between all parties involved.

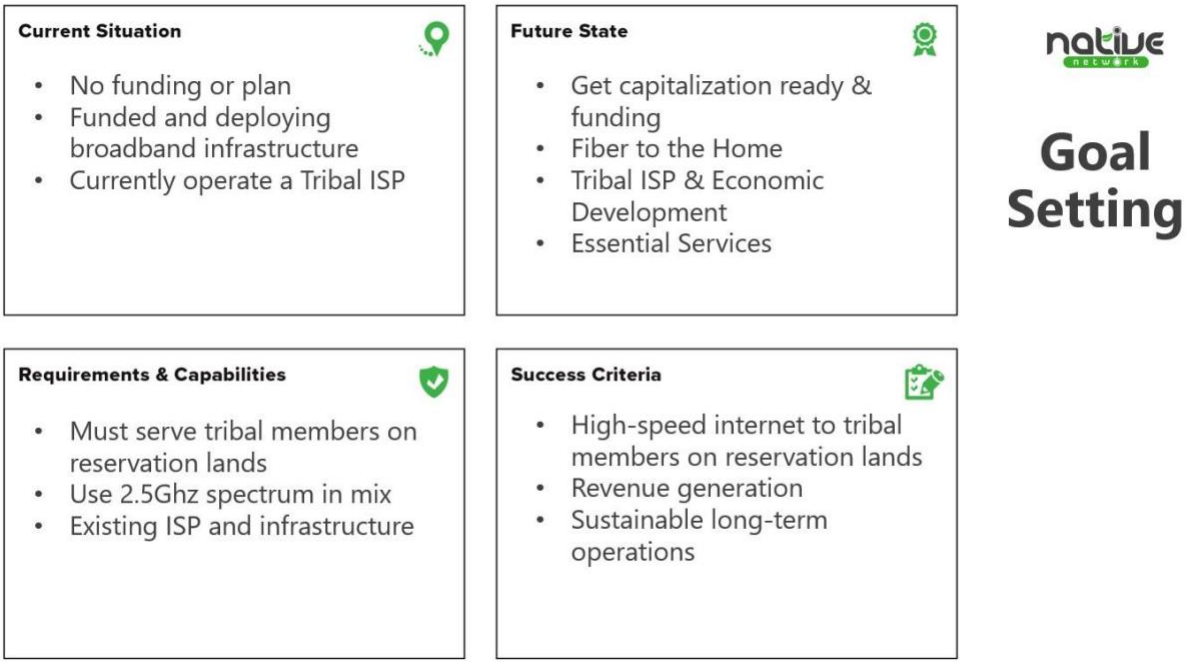
During outreach, find out how a high-speed broadband network could benefit your entire community and the people your Tribe will serve. For example, conduct surveys with your Tribal members and the community to

discover what services will excite them. Tribal housing can also provide insight into homeowner demands and trends of how improved broadband impacts the community. Please speak with your schools, advanced educational facilities, and libraries about how broadband might improve their needs and explore ways to work together. These are vital tasks in creating a successful vision statement.

Goal Setting

Goal setting is an essential part of any successful project, and this is especially true for broadband projects. Setting clear goals helps ensure that the project team remains focused on the project's objectives while providing a roadmap for success. By setting well-defined goals, teams can increase their chances of success by clearly understanding what they are trying to achieve and how they plan to get there.

Setting goals includes four primary conditions to analyze: Current Situation, Future State, Requirements & Capabilities, and Success Criteria. Below is an example of how this method may be used:



Feasibility and Funding

A vital part of preparing to embark on a broadband deployment project is determining the feasibility of the endeavor, how to fund the deployment, and how to ensure the resulting business is sustainable in the long run. These three essential tasks are outlined below:

Financial and operational feasibility study

- Performing a financial and operational feasibility study will inform the Tribe of whether building, operating, and maintaining a broadband network and providing services is feasible, given a certain set of assumptions.
- Steps needed to generate the required assumptions include a market analysis that will inform pricing, service packages, current service availability, and other vital issues; a high-level network design that will provide inputs into the financial forecast; and a financial forecast that incorporates the various assumptions and shows decisionmakers and other stakeholders how the broadband project performs over time.

- Note that funding is available for feasibility studies and pre-construction activities from various sources, such as the USDA/RUS Broadband Technical Assistance program and California's Local Agency Technical Assistance and Tribal Technical Assistance programs.

Determining funding needs and locating the funding

Funding can come from many places, including internal funds, bank loans, federal government loans, and federal grant programs. Currently, a significant amount of federal funding is available for broadband deployment, including specifically for Tribal areas.

- USDA/RUS ReConnect Program: Congress is expected to fund round 5 in the near future. One feature of the ReConnect program is the separate funding category that provides 100% grants (i.e., no matching funds) to Tribal governments.
- Tribal Broadband Connectivity Program: Administered by NTIA, this program will soon have an additional $1 billion (on top of the previous round of $1.98 billion) available for grants to fund broadband network deployment, planning and feasibility, and use and adoption activities in Tribal areas.
- Broadband Equity, Access, and Deployment (BEAD) program: This program, also administered by NTIA, will provide $42.45 billion in broadband-related funding to states and U.S. territories, who will then decide how to award funding to subgrantees (which include Tribal governments). Still in the planning stages, states/U.S. Territories decide what areas will be eligible and how funding will be awarded.

Long term business plan, including solving sustainability issues.

- Once funding has been procured, the Tribe should begin to engage in long-term business planning to ensure that the resulting provision of broadband internet access service is sustainable well into the future.
- Assumptions made in the initial feasibility study should be revisited to determine if changes need to be made that affect pricing and operational decisions.
- Programs should be explored that will help ensure broadband services are affordable for low-income and other vulnerable residents – the federal Lifeline program provides up to $34.25 per month in credits for broadband and broadband/voice services in Tribal areas and is funded by the federal universal service fund; the Affordable Connectivity Program (ACP) provides up to a $75 per month credit for broadband service for those living on Tribal lands, and is funded by Congressional appropriations.

Partnerships

Perhaps your tribe wants to ensure broadband access for your community but is not prepared to become an ISP on your own. There are numerous ways to structure partnerships that can leverage your tribe's existing infrastructure, relationships, and community knowledge with the help and operational expertise of a partner, or partners. No two partnership arrangements are the same, but here we offer an extremely high-level outline of questions and best practices to help you think about what a partnership might look for your tribe. A couple critical questions as you consider a potential partnership:

What do you want to accomplish?

For instance, do you want to provide just residential broadband, or do you want to offer customized business services also? Do you want to offer a video (television) service?

What assets and resources do you have, and what is still needed?

These assets can be existing fiber cable, buildings/huts with space for broadband equipment, utility poles, available conduit, staff, office space and expertise, systems for billing, customer service, and mapping, or leeway for make ready engineering costs or right of way access.

Once you've identified your goals and potential broadband assets, it's good to think through which elements of a broadband operation your tribe wants to contribute, and those for which you want a partner. Some examples include:

- Managerial/Technical expertise (Do you have this on staff? Need to hire? Want a partner to bring?)
- Fiber infrastructure (Main line fiber, fiber drops)
- Electronics (Data electronics, customer premises equipment)
- Who interfaces with the customer? (Call for service, equipment installation, trouble tickets, customer service)
- Is it a revenue and cost sharing model, or a lease model, or something different?

With a vision in place of the areas in which you may want to share responsibility, think through potential partners that can help you in those areas. Consider your "neighbors" – nearby internet providers, utilities, or community networks. You can approach them yourself or have a third party manage an RFP to help choose between potential partners.

Remember that you do not have to give up ownership or control to benefit from a partnership relationship. Best practices for a broadband partnership often follow the idiom of "good paperwork makes good friends." This "paperwork" includes clearly defining roles and responsibilities of each party and establishing the correct contracts, agreements, and legal structures to support the shared vision. Working with a third party to create this partnership is often a good idea, as it allows for some neutrality and an outside perspective as everyone works through details together.

Economic Development for Tribes

Impact of Broadband Networks

To advance and create long-term success of our tribal communities, economic development is key. High-speed internet has become a common denominator for successful economies expanding opportunities for growth, both personally and collectively, and improving the quality of life. With broadband networks, our tribal communities can see the benefits that other similar communities have experienced including job creation, access to various forms of education and essential telehealth services. As the economy develops, our tribal members that had to make the hard decision to move for financial stability or health needs are given the opportunity to return home not only to survive but to thrive within our community for the unforeseeable future.

Job Creation

Broadband networks not only carry information to end-users, but the deployment and installation of these networks creates new job opportunities and skills that can become future careers. With over $45 billion being invested into the digital infrastructure of rural America including our tribal communities, the need for skilled workers will only increase with time. Workers with the skills of splicing, testing, installing, troubleshooting, monitoring networks, data collection of devices in field, and training our older generation on the internet, will be a necessity within the tribes.

Not only are jobs created within the broadband industry for the deployment and maintenance of the network, but jobs that might have meant relocation to our members are now accessible through that network by means of remote workplace.

- Educators can mold and shape minds inside and outside of the tribes' boundaries.

- Entrepreneurs and business owners can expand their reach around the globe.
- Technology professionals can commute from their living rooms to transform the digital world.
- Doctors and dentists can expand their practices through telehealth options.

Online Education Access

In all our tribal communities, children are the heartbeat and pass down our great culture and traditions. They deserve the best options for their individual growth and development in education. Broadband networks provide opportunity not only for our children but for our young people, our adults and seasoned elders to grow in knowledge, build skills and expertise, and open a world of innovation through access to quality education and training at the elementary, secondary, collegiate, and post graduate levels.

Telehealth Access

With healthcare being essential to human life, broadband networks provide direct access to telehealth. Tribal members have the option for visits and consultations direct from their home. A modern convenience that urban areas have had for years, now can keep our members healthy and in turn keep our communities strong.

Bringing long-term sustainable growth, broadband networks will advance our tribal communities with increased job opportunities, direct access to education at all levels and to life saving healthcare professions, so we can flourish in the new digitally connected world.

Design & Construction and Engineering

Network Design

Core, Edge & Aggregation Network Design

Security

Security concerns are an unfortunate reality in network design. First and foremost, your network should use the established best practices related to infrastructure security of the network equipment like unicast Reverse Path Forwarding (uRPF) and aggressive filtering of malicious traffic. In addition, security of your routing protocols – especially BGP should be considered as codified in the" Mutual Agreed Norms of Routing Security (MA NRS)". On top of the infrastructure security, you should consider that security threats may originate from your customers and may target your server infrastructure. Such threats can effectively be mitigated through DDoS protection mechanisms.

Capacity

IP network designs in the past have treated IP routers and their capacities as a scarce resource. Over the last few years however, innovations in router architectures and optics made IP capacity readily and abundantly available to network designs. Abundance of IP capacity allows for more streamlined network designs that provide increased resiliency as well.

Aggregation sites, backbone, middle-mile

The Backbone or Middle-Mile portion of a broadband network is generally considered the segment between the Access Edge and Core Router domains. The Backbone can be made up of single or multiple spans, contain ring or mesh topologies and may include relatively long-haul routes over great geographic distances.

At its heart however, the backbone or middle-mile of a broadband network is characterized by a few consistent features:

- **Scalable Capacity** – Allowing a provider to start with current bandwidth requirements but quickly scale to 100s of Gigbits or Terabits of throughput.

- **Geographic Reach** – Middle-mile technologies provide the capability to span long distances, from local to regional or even continental.
- **Service Awareness** – A key consideration that enables a broadband network to identify and engineer custom traffic handling for customers based upon their requirements and revenue impact to the provider.

Backbone Technology

As with most things, the question of 'how do I build a Middle-Mile network' is answered with 'It Depends'! To be clear however, there are three primary methods of traffic transport each with its own pros and cons. These can be implemented either as stand alone or in combinations to suit your requirements.

- Optical (Layer 1) Transport – Typically this refers to the use of Dense Wave Division Multiplexing (DWDM), a technology that provides multiple data streams over a single pair of fiber. Can also be amplified to reach long distances. Offers little in the way of traffic engineering or service awareness.
- Switching (Layer 2) - Switching technology is where rudimentary protection protocols and customer identification becomes available. For years was the defacto standard for smaller networks and is still a valid architecture if it meets your requirements.
- Routing (Layer 3) - As mentioned above, IP routing is quickly becoming the most popular method of middle-mile network design. A combination of increased bandwidth throughput and advanced service aware protocols makes it an excellent choice for the modern broadband network.

There are many variables in designing your middle-mile network but here are a few points to consider as a starting point.

Traffic, How Much and How Far?

What are your current traffic requirements in terms of raw bandwidth? This can be as simple as counting the number of subscribers, assigning each a level of usage and then totaling it up. This will give you a starting point as to what bandwidth your backbone will need to support. For example, let's say I have 1000 subscribers, each using 100Mb of service on average. (1000 x 100Mb = 100Gb - Of course traffic usage waxes and wanes and so your needs may vary over time.)

How far do you need to go with your traffic? Do you have a modest small county-sized network or are you building a regional ring that will cover hundreds of kilometers of distance? If the latter, a technology such as DWDM may be of value as its reach can be amplified to sustain a signal over great distances.

What Services Will You Offer?

With the advent of new and more cost-effective routing technologies and the latest traffic engineering protocol developments, many providers are implementing more advanced service offerings in addition to simple internet access. These services require more than simple aggregation and transport, they require *Service Awareness*. A service-aware middle-mile backbone is capable of supporting traffic aggregation, identifying and categorizing customers based-upon their service tier (e.g. Gold, Silver or Bronze level) and then applying appropriate traffic engineering to enhance and guarantee the online experience they're paying for. This in turn keeps the customer happy, increases their 'stickiness' to your business and reduces attrition to competitors.

Here are a few 'value-added' services in common use today:

- Protection – Simply put, providing resiliency to service outages to ensure your customer's traffic stays up in the event of hardware or software failure. Many options are available, most allow a traffic 'failover' path that activates without the customer even being aware when trouble strikes.
- Encryption – Available at the Optical or Switching/Routing Layers, encryption of customer traffic is becoming increasingly important in today's security-conscious world.
- Low-Latency – Usually, the response time we see as internet users is measured in millseconds (1000ths of a second), however there are many users that depend upon much lower latency for their home businesses or other online pursuits. Low latency can be traffic engineered to suit.

- Bandwidth on Demand – Allowing a customer to access additional bandwidth whenever and wherever they need it on a temporary or permanent basis.

Operational Simplicity

Today's network options and service features are many and managing them may seem complex. Fortunately, most vendors in the industry are matching their advanced hardware capabilities with management software that offers a graphical, intuitive and easy to use method of service delivery to your customers. Service provisioning, monitoring, management and troubleshooting are, in many cases, available in a single screen and adaptable to users from top-level administration to field technician.
Tools such as in-line, in-service OTDR, performance monitoring, event notification via SMS messaging and service-level-agreement (SLA) reporting can be very valuable in terms of keeping customers happy and these should be a part of your top-level management tool.

Access type: Pros & Cons

OVERVIEW

Unlike the Core, Edge and Aggregation network, there are many choices for last mile broadband technologies. Fiber-to-the-Home (FTTH) is considered to be the future-proof solution in terms of capacity and resiliency; however, it is expensive and slow to deploy. Moreover, there are many Tribal lands where it may not be possible to deploy fiber.

There are several wireless technologies that provide a viable alternative to fiber. Wireless technologies have the advantage of being much quicker and cheaper to deploy and some of the technologies will provide symmetrical gigabit speeds to the home.

Two other technologies to consider are WiFi and satellite. WiFi provides very economical high-speed broadband in small areas and is commonly deployed as community hotspots from Tribal agencies. Satellite provides immediate broadband with limited bandwidth and is suitable for very remote locations.

The following table provides a high-level overview of the characteristics of different broadband access technologies:

Use Case	Technology	Characteristics						
		Bandwidth	Resiliency	Coverage	Speed to deploy	Cost to build	Cost to operate	Future-proof
Business / Government	Active Ethernet (Fiber)	🟢	🟢	🔴	🔴	🔴	🟡	🟢
Urban Residential	PON / XGS PON (Fiber)	🟢	🟡	🔴	🔴	🔴	🟢	🟢
Suburban & Rural Residential	Fixed Wireless mmWave	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Mobility	LTE / 5G / oRAN	🟡	🟡	🟢	🟡	🟡	🟡	🟢
Community	WiFi Mesh	🟡	🟡	🔴	🟢	🟢	🟢	🟡
Remote	Satellite	🔴	🔴	🟢	🟢	🟢	🟢	🟡

Fiber

GPON, XGS-PON, NG-PON2: Next-generation PON networks support new subscribers and devices that have led to a surge in data traffic. GPON has enabled 2.5 Gbps downstream and 1.25 Gbps upstream, but XGS-PON is intentionally designed to use different wavelengths outside of the spectrum allocated to GPON. XGS-PON can deliver 10 Gbps speeds to both businesses and households and allows for the re-use of many portions of the ODN by co-existing on the same

fiber with GPON. NG-PON2 systems have a baseline capacity of 40 Gbit/s using four wavelength channels with line rates of 10 Gbit/s downstream and 2.5 Gbit/s upstream.
Active-E: Active Ethernet may be employed as an alternative or augment to Passive Optical Networks (PON) described above. Active Ethernet provides connection speeds up to 400 Gigabit per second today. This increase in bandwidth comes however at the expense of either a dedicated fiber (pair) or wavelength between the customer premises and the central office.

Wireless

Wireless systems are typically distinguished by their technology (for instance, wifi, proprietary, LTE, 5G), spectrum (such as exclusive use licensed, shared licensed and unlicensed), and specific application (such as Point-to-point backhauls, multipoint access technology for last mile or last 100 feet). The choice of system depends on the requirements of the application, the specific use-case, and the budget. The combination of technology and frequency can significantly influence the system's speed, ease of operation, footprint, number of tower sites or points of presence, and susceptibility to interference as well as its future-proof capabilities.

Moreover, it is common for a single project to encompass various kinds of wireless systems or a hybrid wired/wireless architecture. One might, for instance, employ a licensed microwave link for backhaul to deliver bandwidth to a remote tower location. From that point, exclusive use licensed 2.5GHz or lightly licensed CBRS frequency could provide last mile connectivity via 4G LTE or 5G technology to businesses and residential units. Then, unlicensed Wi-Fi technology could then be utilized for the final 100 feet of connectivity within a residence, ensuring device connectivity for phones, tablets, computers, TVs, and the like.

Utilizing licensed frequency bands guarantees a degree of protection from interference, with lower interference leading to an overall improvement in signal quality. This typically results in better broadband quality, faster packages over extended distances.

Standard-based wireless systems offer interoperability, a robust ecosystem, and scalability, giving users access to a wide portfolio of devices from various manufacturers, ensuring flexibility and cost-effectiveness. Conversely, proprietary wireless systems facilitate tailored solutions with specialized performance and control, but limit device choices to those offered by the specific vendor. The decision between standard-based and proprietary systems entails evaluating specific use cases, device compatibility and variety, as well as considerations for long-term support and technology evolution.

Wireless systems offer rapid and efficient deployment and can cover large geographic areas while serving multiple residential users within their footprint in a cost-effective way. However, it is highly recommended to engage with a reliable technology partner and industry consultants to ensure the system is accurately designed and implemented.

Throughput, Capacity and Oversubscription

Sector capacity in wireless networks denotes the maximum volume of data that can be transmitted within a particular sector, whereas throughput represents the actual data transmission rate such as a speed test. Both are critical metrics in assessing network performance. Oversubscription is a common practice where service providers allocate more potential bandwidth to users than is available, under the assumption that not all users will utilize peak bandwidth simultaneously.

However, a delicate balance is necessary. Excessive oversubscription can cause network congestion, negatively impacting throughput and user experience. To mitigate this, service providers should closely monitor network loads and implement dynamic traffic management techniques. This ensures that critical

services maintain high performance even in peak times and optimizes the utilization of sector capacity without compromising the quality of service.

Funding considerations/ Requirements

If your tribe has received funding from a state, federal, regional, or agency organization to support your broadband network, the funds have likely come with requirements such as the speed you must offer, the number of locations you must serve, and deadlines for completing the network construction and offering service. It is imperative that these requirements be understood at the very beginning of the design, so they can be designed for, monitored, and met.

Additional Considerations:

BUILDING YOUR TEAM Having the right people in the right places is critical to a successful deployment and operation. In most ISPs, there is a combination of in-house staff and outsourced consultants or resources; the exact balance will depend on staffing levels needed based on the size of service market and which services are offered. Commonly required positions include:

- Technicians are experienced in maintaining the outside plant facilities, the central office/data center, distribution electronics, and data network elements.
- Staff with experience in operating and maintaining the broadband network, including subscriber turn-ups, troubleshooting network issues, and performing network maintenance and repair.
- Customer service, both during and after regular business hours.
- Marketing and Sales
- Information Systems and Billing
- Finance, Legal and Regulatory

If federal loan or grant funds are used to support your project, the federal agency will typically require other licensed professionals be involved with and sign off on aspects of the project. These may include:

- Professional Engineer
- Land Surveyor
- Archeologist
- Certified Public Accountant

How do I get my internet access upstream?

The ultimate reason for your network's existence is to be able to communicate with the Internet at large. However, "The Internet" does not exist – it is a large collection of individual networks that exchange traffic amongst each other which project the illusion of "The Internet".

Each of the individual networks that constitute the Internet is identified by an Autonomous System Number (ASN) and each ASN is associated with Internet Protocol (IP) address space. The problem to solve when connecting to "The Internet" is making sure your customers can reach all the address space of all ASNs and vice versa.

The word "Autonomous" is to be understood literally – within some very wide limits you are autonomous in how you operate your ASN. To connect to the Internet, you would contact the American Registry for Internet Numbers (ARIN) to request both an ASN and IPv4 and IPv6 address space. We will return to the considerations for IPv4 address space later, as this is a very scarce resource.

With your assigned ASN and address space you are now ready to connect to the Internet Service Providers (ISP) that act as your "upstreams" – the ISPs that deliver your traffic to the Internet at large and vice versa. Traffic exchange between ASNs is governed by two distinct operating models:

- (IP) Transit. The upstream will deliver traffic to/from anywhere on the Internet for a fee.
- (IP) Peering. The upstream will deliver traffic to/from their own address space. This is typically done in a "Settlement Free" manner, no money is exchanged.

To qualify for an ASN, ARIN requires you to have at least two distinct upstreams (two different ASNs that provide transit to you). If possible, choose your upstreams so that they provide geographic redundancy as well.

"The Internet" having grown out of a more academically minded environment still has remnants of that cooperation in the form of Internet Exchanges (IX). These are membership-funded entities that (typically) reside in data center locations where traffic is freely exchanged ("peered") between members. A sensible approach to connecting to the Internet should include peering with as many members at the IXes as possible, since this will decrease the amount of traffic you will need to buy from your transit providers. As an added benefit, an ever-growing number of content providers (think of streaming services, for example) offer peering at these sites. A list of Internet Exchanges and the networks that can be reached can be found at the Peeringdb (link). Of course, such cooperation can also be established between members of NTTA – through bilateral or multilateral agreements ("private peering").

After establishing your transit and peering, the next decision to be made is how you manage your address space. There, you are faced with two extremes:

- IPv4 address space is extremely scarce.
- IPv6 address space is abundant.

The North American Internet (as managed by ARIN) ran out of freely available IPv4 addresses in 2015, so all IPv4 address space given out by ARIN (e.g. to new ASNs) is in either small blocks or through a waiting list whenever IPv4 address space is returned to ARIN. As a result, you should minimize the use of this address space for your network's infrastructure as much as possible, preserving it for use by your customers. For new network deployments, there are network technologies readily available that only use IPv6 address space in the infrastructure (e.g. Segment Routing over IPv6).

On the other hand, there is plenty of IPv6 address space available. You can and should be generous with IPv6 and provide to your customers network blocks of /48 to /56 prefix length.

No discussion of Internet connectivity is complete without some words on security. The implementation of routing policies and your security posture and capabilities are inherently linked to the protocol implementing the routing between ASNs – BGP-4. A lot of work has been done over decades on what is referred to as "Routing Security". The "Mutually Agreed Norms for Routing Security" (MANRS) should be considered a mandatory baseline to be implemented.

BSS/OSS Selection

As an ISP you'll need to select a Billing System (BSS) and an Operating System (OSS). These complex systems can be integrated from the same vendor or separate offerings can be used together. They will incorporate detailed network information, customer information, service information, and more. They may also be tied to, or offer, provisioning capabilities that allow a customer service representative to enable subscriber services through the network. While their primary functions of OSS/BSS solutions happen later, it's helpful to select an OSS early in the planning stages so initial design work and field engineering can be completed in the correct system.

Engineering

Field Checklist

Field engineering

Field engineering presents many different challenges based on the construction type and architecture of the design. Major considerations include:

- Terrain
- Rights of Way (public right of way vs. easements and private right of way)
- Rock and other natural obstructions
- Suburban vs. rural (density of other utilities, physical obstructions, etc.)

- Permitting considerations (highways, bridge attachments, railroads, etc.)
- Code considérations (NESC, NEC, etc.)

Having an engineering partner with the necessary skills and experience is crucial for a detailed design that takes all factors into account. The best way to achieve this is to have qualified professionals perform design work in the field. This allows them to have a direct view of the build area and identify any potential issues. With the added advantage of using GIS technology, engineers can design from the field in real time and digitally document any problem areas during the design process. With this, you can simplify the workflows for your FTTx project during the design and construction phases.

Resources: Qualified engineering firms who specialize in Outside Plant (OSP) design can offer valuable insights for the right questions to ask as well as answers to those questions.

What is fiber make ready?

"Fiber make ready" refers to the process of preparing a utility pole to receive a new fiber attachment. This process must be completed when a service provider is expanding fiber service to a new geographical area but is more complicated and takes more time than many people realize.

In most communities, utility poles are owned by the local government, a utility such as the electric company, or the telephone company – or sometimes, a combination of entities. Cooperation with the owner of the poles is necessary for any other service provider to add anything new to that pole, such as fiber-optic cable.

The fiber make-ready process

The process has several steps, as follows:

- The entity wanting to place a new attachment (in this case, fiber) on the pole must contact the pole owner with the request.
- The owner of the pole then determines if there is room for anything new, and rules out any issues with safety or capacity. Any problems must first be addressed before the process moves forward.
- The owner of the pole then sends back the "make-ready" cost to the requestor. This cost must be paid before the process can move forward.
- If the owner concludes there are no issues, every entity that has something attached to the pole must send a worker to the pole to move wires to make space for the new attachment.
- The new attachment can finally be placed on the pole.

This process can be time-consuming, expensive and difficult when multiplied over the number of poles and the number of companies involved. In order to expedite the process, "One Touch Make Ready" (OTMR), where a single contractor is authorized to make all the pole attachment changes at once, has been enabled in a few municipalities – usually through legislation. However, OTMR is not in place or expected anytime soon in some service areas.

Analyze Terrain

ROCK, HILLS, TREES Preparing an area for installation can be costly so looking at optimal locations where there may already be natural clearings or access are ways to ensure the site make ready is not as cumbersome. Clearing for roadways and trenching/boring based on certain rock surfaces can create several challenges and require certain equipment so taking the time to think about the terrain when designing site locations will positively impact your project timelines and cost.

HOW ARE YOU POWERING THE SITE? ON-GRID/OFF-GRID; SOLAR Many tribal locations are more remote and off-grid or pre-grid so ensuring you can support your needs means looking to creative solutions including solar and wind and even battery storage to ensure up-time. Many pre-grid solutions can also serve as your back up power once the site is on grid so thinking thru the entire process of provisioning power and ensuring you are covered even if the grid goes down is key. There are solutions that can also work completely off-grid as well so if there is a location needed for service that is cost prohibitive or challenging to bring in power look to alternative grid solutions before assuming you won't be able to service those areas.

Permitting and Environmental

The permitting process is usually conducted in parallel to the field engineering process. Typically, rural projects have many more involved agencies that require permits than an urban environment. The permitting process often takes 30-90 days and may involve numerous agencies; however, the process may take much longer for certain construction activities planned for federal lands such as US Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), and some Tribal governments. In some cases, the fiber route can be planned to avoid such protected lands resulting in significant time and cost savings.

The environmental requirements vary depending on the project and how the project is being funded. All federal grant programs have stringent environmental processes that must be followed. Such processes can be costly and may cause significant delays to the start of construction. This includes a review of several resources that could be negatively impacted by the construction activities, including cultural and historical resources, wetlands, floodplains, threatened & endangered species, among others. Environmental expertise is necessary to support this effort and, in some cases, may require the assistance of an archaeologist. Care in the initial planning and design of the project can minimize this requirement by finding areas and routes that have minimal impact to the environment.

Requests For Proposals (RFP)

Construction Plan/ Bid package

Based on the engineering, construction plans or a bid package are developed to include the proposed construction maps, guide drawings, and construction standards. The construction plans or bid package are typically combined with contract requirement documents and then utilized in a competitive bid process to select a construction contractor.

Supply Chain/ Logistics

Materials: Fiber, Handholes, Pedestals, Splice cases, Electronics, Snowshoes, Wind dampers (

Supply Chain Challenges to Consider:

- Raw Material Shortages
- Assembled Component Challenges
- Labor Shortages
- Increased Costs across Supply Chain
- Shipping & Logistical Delays

Important things to consider when selecting and evaluating supply chain partners in the RFQ Process:

- Determine business needs
- Who will be procuring material? (Consultant, Contractor, End user)
- Vet out potential vendors
- Set evaluation criteria
- Connect with and evaluate vendors
- Finalize vendor selections

- Services available before & after awarding supplier partner
    - Supplier tenure, experience, stability & reputation
    - Project management of deployment
    - Supply chain management solutions
        - Efficient processes that reduce cost and creates value
        - Assistance in mapping existing processes & remapping work functions to improve processes and efficiencies.
    - Product Sourcing
        - Range of manufacturer support
        - Diversification of product selection availability
        - Sales and customer service support to find what is needed in a timely manner.
        - Cost effectiveness
    - Emergency Services availability
    - Proven product quality and warrantees
    - Accurate quotation services
    - Quality of customer service and ease of access
    - Project order management/on time delivery
    - National Agreements to leverage cost and value add.
    - Jobsite services
    - SmartStock inventory management services (on or off site)
    - Cost reduction programs
    - Rebate Agreements
    - Expansive wire and cable services
    - Technical assistance
    - Technology consultative services
- Managed Services
    - Dedicated Account Manager
    - Dedicated employee resource to manage and streamline your processes
    - Warehouse staging
    - Dedicated warehouse deliveries
    - Contractor fulfillment
    - Custom reporting to assist in material builds and budget review

Construction

Outside plant

Pre-Construction

logistics, materials ordering, sequencing, etc

Construction

Construction is normally the most involved and most expensive part of any project. Managing construction is critical to providing timely customer service, staying on budget, and ensuring the quality of the fiber build. Major considerations include:

Placement and Install – Correctly build what's been specified and ensure it functions properly.

Make Ready – Identify and coordinate make ready work that is necessary to accommodate compliant and safe placement of new facilities (power pole changeouts, etc.).

Utility Locates – Verify all underground utilities are accurately located by contacting the local 811 agency to have them identified prior to any ground disturbance. This ensures the underground utilities are not damaged while also promoting job site and community safety.

Restoration – Restoring the ground and landscape properly after construction crews have completed material installation not only keeps the public safe, but also satisfies property owners and authorities with jurisdiction.

Documentation (As-Builts) – To keep track of the facilities that have been placed on a job site, it's important to have accurate records of the types and quantities of units, as well as other descriptors like plow units, bore units, rock and soil types, pipe sizes, and handhole layouts. Using a complete GIS platform can simplify this process and provide project awareness. This will allow project managers, office staff, and stakeholders to make informed decisions and monitor the construction progress in real time.

Testing – Testing to verify facilities are properly installed and deliver required services. Examples include: OTDR testing, scoping fibers, and possibly protocol/speed testing.

Considerations: Managing customer expectations

For areas that have been underserved, it's very exciting for residents to know that broadband is being built! However, that can lead to disappointment when project timelines set in: It can be years between when a project is announced and when service is available. A best practice is to set expectations early and communicate with residents throughout each project phase to help manage these reactions. Town halls, kick off events, newsletters, community presentations, social media, and other mediums are useful for keeping residents both excited and patient.

Inside plant

Once the fiber network has been constructed, the operations and management of the system begins. This is referred to as Inside Plant, Central Office, or Data Center

Electronics

At the aggregation sites, several electronics systems ust be installed and provisioned. This includes the core data network, transport electronics, access network electronics, and potentially voice service and/or video electronics.

Provisioning, testing

Once the electronics systems have been installed and tested, they must be configured to interoperate, and the appropriate circuits and services must be provisioned. As part of this installation process, the management systems for each of the electronics systems is installed and the service provider's technicians undergo training in the operations and troubleshooting of each of these systems.

Customer location construction

Once the fiber routes have been constructed and the electronics systems have been installed and provisioned, the customer turn-up can begin. This involves constructing a drop to the customer, installing customer premises equipment (CPE), provisioning and testing the customer's service, and educating the customer.
During the installation, crews perform grounding/bonding work and must also interface with or perform rework of the customer's inside wiring. This process requires coordination and scheduling with the customers. Providers may have several staff that are dedicated to maintaining installation schedules and coordinating the installation crews. If using a demand aggregation software, this step should be carefully interfaced with demand aggregation participants.

Operations management

Once the network has been constructed, there are several items that must be considered and completed to ensure the successful operation of the network.

Staffing - Staffing levels need to be established based on the size of the service market and services offered. Commonly required positions include:

- Technicians - experienced in maintaining the outside plant facilities, the central office/ data center, distribution electronics, and data network elements. Staff with experience in operating and maintaining

the broadband network, including subscriber turn-ups, troubleshooting network issues, and performing network maintenance and repair.

- Customer service after hours - Customer support is the team of people who provide help when customers have trouble with a company's products or services. It's ultimately about making sure customers are successful in solving whatever issues they came to your business to help solve.
- Marketing - Responsible for planning, creating, and executing marketing campaigns to expand their company's reach and potential customer pipeline.
- Sales - Sales representatives are responsible for selling a company's products by identifying leads, educating prospects on products through calls, training, and presentations, and providing existing customers with exceptional support. Sales representatives are either inside or outside sales reps. Inside sales reps sell products over the phone and online, while outside sales reps sell products through face-to-face meetings.
- Accounting & Billing Regulatory Considerations State and Federal regulatory requirements are often overlooked during the planning stages of building a broadband network; however, deploying a broadband network comes with a long list of regulatory considerations that could have a strain on operations. The regulations will vary based on the services offered and, in some cases, your network funding mechanism. These are a few of the most common regulatory requirements:
- Obtaining Regulatory Authority and/or Eligible Telecommunications Carrier (ETC) status
- Interconnection Agreements - An interconnect agreement is a business contract between telecommunications organizations for the purpose of interconnecting their networks and exchanging telecommunications traffic.
- Obtaining Numbering Resources and Local Number Portability
- E911 Plans - It is the intent of the Legislature to implement and continually update a cohesive statewide emergency communications number "E911" plan for enhanced 911 services which will provide citizens with rapid direct access to public safety agencies by accessing "911" with the objective of reducing the response time to situations requiring law enforcement, fire, medical, rescue, and other emergency services.
- Tariff Development and Filings – Both State and Interstate Tariffs
- Obtaining FCC Registration Number and Completing Mandatory FCC Regulatory Filings
- CPNI (Customer proprietary network information)Compliance - Usually, this is done at the beginning of a call from the telemarketer to the telephone subscriber. The U.S. Telecommunications Act of 1996 granted the Federal Communications Commission (FCC) authority to regulate how customer proprietary network information (CPNI) can be used and to enforce related consumer information privacy provisions.
- Red Flag Compliance - Red Flag compliance requires the identification of identity theft warning by covered entities in order to better manage identity theft risks.

There are several support systems that a typical service provider deploys to aid in the operations and management of the network. Each of these systems adds costs and requires staff and training to utilize. Common support systems include:

- Mapping - Typically incorporating GPS location information, a mapping system contains information such as cable route, cable size, fiber splicing information and structure placement types and locations.
- Customer Billing & Facilities Management- These complex systems track customer information, financial information, service information, and provide various support functions. These systems may also be tied to flow through provisioning capabilities that allow a provider's customer service representative to enable subscriber services through the network.
- Trouble Ticket - These systems are utilized to log subscriber troubles, assign them to staff for troubleshooting, and for escalating the issues.

From Reactive to Proactive to Predictive

The solution to this conundrum rests on the ability to move away from a reactive approach to network operations tools. In a reactive situation, the issue has already occurred and is already impacting the subscriber. Diagnostics

must be run, root cause determined, and maintenance or a customer visit scheduled. The cost of servicing your subscriber has gone up, and the subscriber has suffered a frustrating experience that erodes customer satisfaction. No one wins.

In fact, in most cases, by the time a subscriber contacts customer support with a problem, they've had the issue for some length of time, have tried to fix it and are looking for an immediate fix or else. They've likely been suffering with the issue for days or weeks, but they haven't yet reached the point of calling customer support to effectively complain about it. Operations teams often therefore have a window to proactively reach out to the subscriber before the subscriber escalates. A customer service representative (CSR) proactively calling a subscriber regarding an issue is better than the other way around. It will end up being a satisfying experience for the subscriber if the problem is resolved quickly.

But do you know what's even better than being proactive? Using predictive analytics.

Below, we touch on five lesson highlights that can help you deliver services and support to delight subscribers for years to come.

- Put the right people with the right training in the right roles.
  First impressions count. Before you launch your services, you'll need to have the right staff and processes in place for functions ranging from network operations and customer support to sales, marketing, and finance. This will help ensure your business runs smoothly—and that subscribers experience high-quality service and support from the start. This lesson will cover the different roles and responsibilities you'll need covered, and how to determine staffing levels based on various factors. These include the size of your service area, projected take rates, and if you're rolling out broadband services as part of your existing operations.
- Understand FCAPS, a framework for network management.
  The broadband industry loves acronyms and another one to add to your list is FCAPS. It's a common network management framework and it stands for ***fault, configuration, accounting, performance, and security management (FCAPS).*** These five tasks are key to keeping your network running smoothly and delivering reliable, always-on experiences. We'll also discuss the role that a software-defined network plays in helping you manage the entire network, better perform FCAPS tasks, and simplifying your overall operations.
- Automate, empower, and equip for success.
  Even the best people, processes, and technologies won't stop the inevitable from happening. At some point, network outages or equipment faults will affect your service. But you can sidestep some of the more common issues that negatively impact the subscriber experience. This lesson explores how you can automate network monitoring processes, empower support teams and subscribers with end-to-end network visibility, and equip field techs with real-time data insights. Together, these will make your broadband operations more efficient, productive, and cost-effective.
- Prepare to provide first-rate customer service**.**
  What good does building the fastest network with the most advanced technology do if you don't have the customer service to match? Developing a subscriber-focused culture takes time and requires commitment from every level within your organization. But it's well worth the effort to foster brand loyalty, reduce churn risks, and differentiate from the competition. We'll run through tactics such as asking for feedback and discuss ways to drive ongoing innovation and service improvement.
- Learn from the experiences of your peers**.**
  Thankfully, you're not alone. Other electric cooperatives, tribes, and municipalities have gone through the process of building and operating broadband businesses for their communities—and many are happy to share their experiences.

Understanding how to position your broadband business for operational success will provide essential connectivity and services for your communities—today and well into the future. The steps outlined above are typical, but there is no one-size-fits-all approach to broadband deployment. Every deployment is unique, knowing your system's goals and needs are specific to the area you serve.

Project Glossary

Company	First	Last	Email	Primary	Secondary
Construction Firms					
CCI	Jim	Howard	j.howard@tularosa.net	OSP construction	Hang or bury fiber
Consulting Firms					
Fonex	Ab	Quinlivan	aquinlivan@fonex.com	Design & build	Carrier ethernet services, ip services
Utilisource	Laura	Wilson	Laura.Wilson@utilisource.us	Compliance	GIS mapping
FR Secure	Troy	Derosier	tderosier@frsecure.com	Grants & funding, project, construction & environmental management	Grants & funding, project, construction & environmental management
Geeks Without Frontiers	Travis	Heneveld	travis@geekswf.org	Workforce development & training	Technology & skills training
Moss Adams	Doug	Kitch	doug.kitch@mossadams.com	Professional services	Accounting, business planning, feasibility analysis assistance
Native Network	Carl	Patterson	cpatterson@nativenetwork.com	Design, feasibility studies	Prosper, support & expansion
Consulting, Design and Engineering Firms					
Vantage Point Solutions	Jacki	Miskimins	jacki.miskimins@vantagepnt.com	Feasibility, funding, partnerships	Engineering & permitting
Finley	Dan	Carter	d.carter@finleyusa.com	Engineering	Broadband & energy
MuralNet	Mariel	Triggs	mariel@muralnet.org	Design, build, implement	Financial & educational
Palmetto	Jeff	Little	jeff.little@palmettoeng.com	Telecoms & GIS - mapping	Right of way
MuralNet	Mariel	Triggs	mariel@muralnet.org	Design, build, implement	Financial & educational
Utilisource	Denise	Frank	Denise.Frank@utilisource.us	Grid resiliency	Gis mapping
Distributors					
Power & Tel	Robin	Mayne	Robin.Mayne@ptsupply.com	Core to edge	Outside plant
Anixter	Dan	Olguiin	Daniel.olguin@anixter.com	Edge	Fiber
Graybar	Trisha	Smith	trisha.smith@graybar.com	Supply chain management	Professional services, equipment financing
Wesco	Chris	Bailey	chbailey@wescodist.com	Network infrastructure	Grid modernization, OSP, OSP engineering services
Netceed/Walker	Joe	Trammell	Joe.Trammell@walkerfirst.com	Core to edge	BBA, core routing
Millennium	Randy	Moore	randyt.moore@mtpllc.us	Infrastructure funding, geospatial services	Infrastructure fund, equipment leasing
Insurance					
Telcom Insurance Group	Jim	Humminbird	jimh@telcominsgrp.com	Insurance, risk management	Cyber liability/network security
Manufacturers					
Adtran	Ashley	Brown	ashley.brown@adtran.com	Edge access	Switching, in-home user experience, edge routing
DZS	Bill	Sproull	bill.sproull@dzsi.com	Access networking & cloud software	Edge solutions
Radisys	Glen	Scymanski	Glen.Scymanski@radisys.com	Network solutions	Customer development services
Calix	Claudia	Tarbell	claudia.tarbell@calix.com	Managed services, professional services	Marketing cloud
Cisco	Alistair	McGrath	amcgrath@cisco.com	Fixed & wireless broadband networking	Collaboration, security, data center, campus switching, IoT
Ribbon	Jack	Breeding	Jack.Breeding@rbbn.com	IP & optical networking solutions for 5G	Core to edge software-centric solutions
Hubbell Power Systems	Jamie	Pickup-Grogg	jpickup@hubbell.com	Data & communications, electrical & electronic	Outside plant, ground vaults, pole-line hardware
TelRad	Alex	Freylekhman	Alex.Freylekhman@telrad.com	Wisps, rural & private solutions	Customer-premises equipment
Ericsson	Ray	Sabourin	ray.sabourin@ericsson.com	5G network infrastructure	5g transport & private networks
BEC Technologies	Andy	Germano	agermano@bectechnologies.net	WWAN, fixed wireless	Wireline access
Software Companies					
GLDS	--	--	--	Billing & provisioning software	Workforce management
Hybrid Power					
HCI Energy	Heather	Wilkins	Heather.Wilkins@hcienergy.com	Turnkey powerhouse	Energy innovation & optimization
Workforce Training Firms					
Telecom Training Corporation	Melissa	Harris	melissa@telecomtrainingcorporation.com	E-learning for telecommunication & wireless	Cable tv, & electric power industries

Group Definitions

Build
Construction companies build the infrastructure that will carry signals and data over it for delivery of high speed internet services. The infrastructure that they are installing is typically fiber cable or wireless networks. Including hanging or burying fiber, building towers, and facilities.

Consulting
A professional services team that will consult and provide feedback to your company on suitability, opportunity analysis, and things to consider before making decisions.

Consulting, Design and Engineering Firm
Engineering and consulting firm. They meet with your company and design layout of entire network start to finish based on all specifications needed to deliver internet services.

Distributor
A company that is focused on bringing product solutions, that will often times provide inventory, or supply chain management to line up with the timing of your deployments. They may have other important services to help enable the design work laid out by the Consulting, Design and Engineering firms.

Insurance
Insurance group specializing in Telecommunication Industry,operation risk control and maintenance.

Manufacturers
These companies make products and solutions. They are the equipment manufacturers. They build the products that the Consulting, Design and Engineering firms will put into your network design and plan that will enable the delivery of the broadband services to your tribal constituents. Each manufacturer will have a product or group of products that they specialize in for the network. Some offer many more products than others.

Operating software
Software used to provide billing services to your customers for the broadband services that you provide.

Hybrid Power
HCI Energy provides continuous, turnkey, eco-friendly power around the world. Whether on grid, off grid or even pre-grid, HCI combines the latest in power technology to ensure round-the-clock, uninterrupted power that lowers operational cost while facilitating crucial business and community operations in a sustainable and eco-friendly way.

Workforce Training Resources
Training & resources available to enable your company to learn how to operate telecom projects from start to finish and hiring resources, and continual training.

Contributors

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