NORTHWEST FIBERWORX

BROADBAND BUSINESS PLAN

PREPARED BY: NRTC BROADBAND SOLUTIONS

FEBRUARY 3, 2022

Member driven. Technology focused.

CONTENTS

Executive Summary

The Covid-19 pandemic, along with other influencing socio-economic factors, has drastically increased consumer demand for reliable high-speed broadband. Applications like telehealth went from a developing future trend to a routine form of care overnight. Schools that were considering how remote learning could potentially supplement curriculum were forced to implement programs immediately. Labor pools are stressed and the workplace, not only in office environments but in industries such as agriculture, will likely never be the same again. In the face of this need to extend broadband infrastructure to places where it does not exist, significant funds through private, local, state, and federal grants have become available throughout the country. The NRTC Broadband Solutions team worked with Northwest Fiberworx to create a business plan that leverages some of these programs to achieve the following goals:

Executive Summary Table	
Backbone & Distribution Fiber Miles	1,367
Backbone & Distribution Infrastructure Capital Expense	$53M
Total Project Capital Expense with Drops to Anticipated Subscribers Included	$72.9M
Project Length	3 Years
Premises Passed	28,176
Take Rate	45%
Subscribers	12,679

- Offers service to all unserved/underserved residents of member towns.
- Incorporates a plan that will ultimately offer fiber to all town premises not currently served by fiber.
- Will serve as an open access network.
- Respects the challenges of delivering rural broadband.

NRTC and NWFX created a full business model where NWFX would build the fiber infrastructure, including the drops. NWFX would maintain the fiber infrastructure most likely through a maintenance contract with a third party. It would not build, own, or support any active network components and would instead anticipate that carriers offering service on the network would bear that responsibility. It is possible that in the future NWFX may add this capability in order to offer enterprise level services to larger, industrial clients. Until that time, the model accounts for only the operational needs and expenses of supporting an open access network.

Project Scope

Town Scope

Demand points, or passings, were identified as any home or business that was not currently served by fiber. This eliminated 1,040 addresses that have access to 100/100 Mbps service in the towns of Highgate, Sheldon and Fairfax. The "SITE" type code provided in the state E-911 ESITE data was used to eliminate locations that did not fit the description of a potential broadband subscriber. Additionally, 225 off grid addresses were removed from the plan as NWFX does currently have a practical way of offering services to these residences. They may be added a future date.

The project would be built on approximately 639 miles of Green Mountain Power plant and 824 miles of Vermont Electric Co-Op plant. These leaves just under 250 miles of municipal electric plant that is to be built upon.

Northwest Fiberworx Key Data Point Table

Town	Passings	Electric Span Miles	Linear Density	Backbone Miles	Anticipated Fiber Distribution Miles
Alburgh *	1,841	77.8	23.7	11.7	62.2
Bakersfield	679	61.7	11.0	9.3	49.4
Berkshire	732	75.6	9.7	11.3	60.5
Enosburgh *	1,283	94.2	13.6	14.1	75.4
Fairfax	1,010	53.7	18.8	8.1	42.9
Fairfield	968	124.6	7.8	18.7	99.7
Georgia	2,062	95.0	21.7	14.2	76.0
Grand Isle	1,304	62.1	21.0	9.3	49.7
Highgate	1,759	93.0	18.9	14.0	74.4
Isle La Motte	568	28.1	20.2	4.2	22.5
Milton	4,280	130.9	32.7	19.6	104.7
Montgomery	859	83.3	10.3	12.5	66.6
North Hero	1,030	53.2	19.3	8.0	42.6
Richford	1,079	68.4	15.8	10.3	54.7
Saint Albans Town	3,192	102.6	31.1	15.4	82.1
Sheldon	877	65.2	13.5	9.8	52.1
South Hero	1,530	64.4	23.7	9.7	51.5
Swanton *	3,123	104.2	30.0	15.6	83.9
Totals	**28,176**	**1,438**	**19.6**	**216**	**1,151**

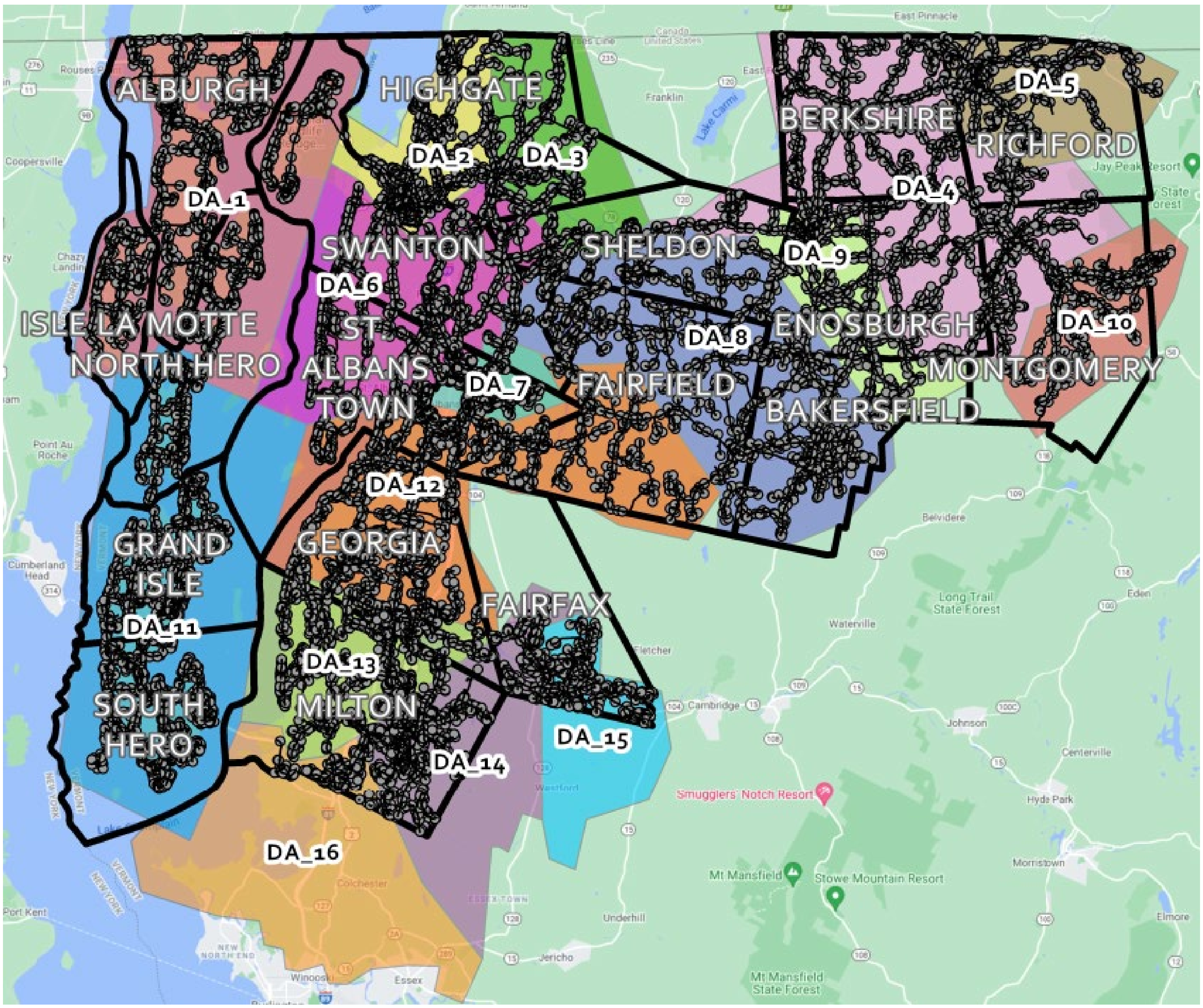
* VT E-911 ESITE data set does not separate out village areas. Data includes incorporated villages.

Distribution Area Scope

Once the demand points and associated miles per town were agreed upon, we created Distribution Areas (DAs), or service areas, that would be made up of parts of multiple towns in an effort to balance commercial considerations with meeting community goals.

The fiber optic cable will follow utility lines emanating from substations. Those substations will likely be the hub locations. Since those substations serve multiple towns, it made more sense to divide the region into distribution areas that followed those routes.

Sixteen DAs were defined, although it is possible depending on potential Optical Line Termination (OLT) locations identified by a town survey that the network could be built with as few as 14. In creating them, an attempt was made to follow the power where it was available and use the substation polygons as a basis for service area polygons. Where power information wasn't available, we tried to replicate the characteristics of a service territory where it did. There was also an effort to create some commonality amongst the DAs so that NWFX can be adaptable should field conditions prompt modifications.



The service polygons were divided into to four separate zones, each a standalone subset project of the larger total project.

The zones are as follows:

[redacted]

Zone	Miles	Passings	Density
Backbone	216	0	0.0
Phase 1	284	5,568	19.6
Phase 2	432	12,445	28.8
Phase 3	269	4,071	15
Phase 4	166	6,092	36.7
Total	1,367	28,176	20.6

It is anticipated that the zones will be supported with approximately 216 miles of backbone. The whole of the territory presents some challenges in terms of being able to create a single redundant ring. More likely the NWFX will need to see opportunities for resiliency through multiple Direct Internet Access locations.

These distribution areas could change once the project moves into low level design. Multiple factors could prompt change to the plan, including:

- Make ready – the poles NWFX will install on will need to be prepared to place fiber on them. The multiple utilities that own these poles will complete make ready at varying rates due 1) current plant condition 2) make ready policy 3) crew availability 4) existing third-party attachments.
- OLT locations. NWFX has surveyed its towns and villages for possible sites to locate electronics. Depending on location selection either by NWFX or any carrier on its network, the DAs may need to change to accommodate distances or subscriber load.
- Access to upstream circuits – any area NWFX would like to build in will need to be "lit" with access to an upstream circuit or backbone built to it.

NWFX should remain agile and adaptable during its build.

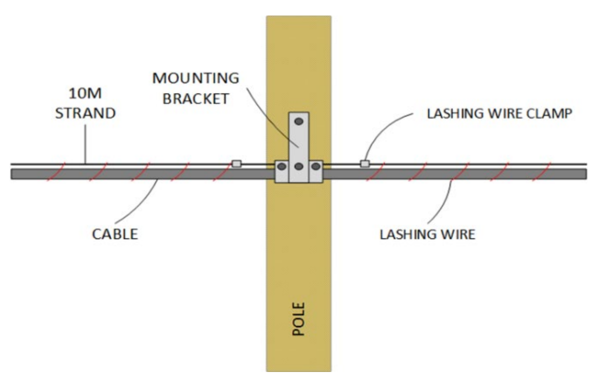
Below is the Key Data Point table organized by distribution area.

Name	Passings	Electric Span Miles	Linear Density	Backbone Miles	Anticipated Fiber Distribution Miles
DA1	3,411	150.2	22.7	22.5	120.1
DA2	2,303	72.5	31.8	10.9	58.0
DA3	895	52.2	17.1	7.8	41.8
DA4	1,624	174.1	9.3	26.1	139.3
DA5	1,023	60.9	16.8	9.1	48.7
DA6	2,516	110.6	22.7	16.6	88.5
DA7	599	20.6	29.1	3.1	16.5
DA8	1,703	167.7	10.2	25.2	134.2
DA9	1,003	55.7	18.0	8.3	44.5
DA10	421	46.0	9.1	6.9	36.8
DA11	3,320	154.3	21.5	23.1	123.5
DA12	3,266	166.4	19.6	25.0	133.1
DA13	2,310	83.1	27.8	12.5	66.5
DA14	2,745	71.3	38.5	10.7	57.0
DA15	616	38.1	16.2	5.6	30.6
DA16	421	14.7	28.6	2.1	11.9
Totals	**28,176**	**1,438**	**19.6**	**216**	**1,151**

Technology Selection

Fiber Architecture

The Northwest Fiberworx business plan is based on strand and lash fiber. The design philosophy includes a prevalence of splice cabinets to allow for maximum future flexibility as it is significantly less expensive to create these placements at the time of installation than it is to go back and add them after.



In this type of construction, a steel support strand is placed on pole line and is fixed in place with a mounting bracket. A fiber cable is attached to the support strand with a lashing wire and secured via wire clamps. The lashing wire is wrapped using a pulled lasher along each span.

One advantage enabled by strand and lash is that since it is not located in the power space, the labor qualifications can be less costly. In addition, if in the future there would be a need or desire to over-lash, this is easily done.

Three quarters of the backbone is modeled to be 144 count fiber with the remaining 25% modeled at 288. Depending on NWFX requirements and goals, this may turn out to be a conservative estimate. Distribution mainline is modeled at 48 count fiber. Again, NWFX may choose to push these counts higher in some areas to account for densities and fiber allocation planning. Likewise, NWFX may size down in some of its more rural areas or choose to replace some of the mainline distribution cable with pre terminated terminal solution.

The goal of making these selections is not to create design, but to conservatively model capital expenses.

Network Architecture
The NWFX plan is built on GPON architecture. As NWFX moves forward with the project, it may explore if there would be benefits to a Distributed Split or Centralized Split architecture. It may be the best use of capital to deploy a hybrid of both depending on distribution area densities.

Centralized Split Network Overview

Centralized Split architectures are commonly used by network operators for initial deployments. This approach relies on centrally located single-stage splitters, which enable flexibility when it comes to managing subscribers and equipment. Typically, centralized architectures use a 1x32 splitter that is connected directly to a GPON central office-based Optical Line Terminal (OLT) on one side. On the other side, 32 individual fibers are routed to provide connectivity to unique subscribers as seen in Figure 1: Typical Centralized Split.

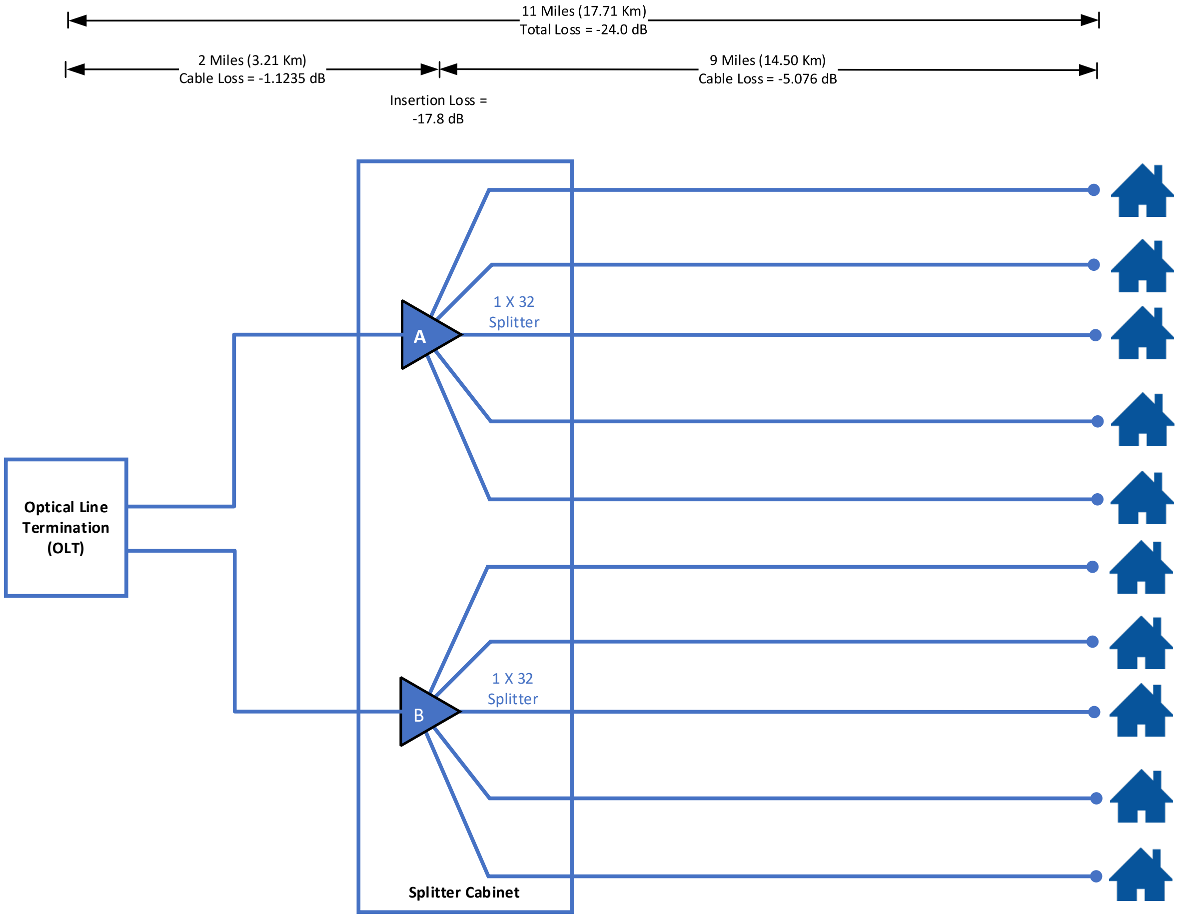


Figure 1: Typical Centralized Split

Maximization of the Optical Line Termination (OLT) equipment and optical splitters is the biggest advantage of a Centralized Split Architecture. Since all optical fibers are home run from the customer premise to a centralized optical cross connect all new adds utilize the same OLT Port/Splitter until all ports are exhausted. Additionally, the home run architecture allows for new Point to Point (P2P) types of services such as E-LINE, E-LAN, MPLS, etc. to be provided. The centralized location for the termination of all fibers allows easier troubleshooting and record keeping.

A downside of Centralized Split architectures is the high deployment costs on a per-home basis. Larger cable sizes are required to home run fibers from the customer premise to the Splitter Cabinet. Since most Distribution Areas (DA) average approximately 1300 subscribers, this can result in very large fiber sizes required to serve the DA. Simply put, a 288-fiber cable can only serve a maximum of 288 subscribers beyond the Splitter Cabinet. Five (5) 288 fiber cables would be required to serve all of the 1300 subscribers. Another disadvantage is distance limitations associated with a Centralized Split. As stated above, a Centralized Split Architecture will normally use 1X32 Splitters to maximize equipment utilization. In the model shown in Figure 1 a Splitter Cabinet is located 2 miles from the Optical Line Termination (OLT) equipment. Assuming a cable loss budget of -24dB from the OLT to the customer premise this architecture limits the distance from the Splitter Cabinet to the customer premise to approximately 9 miles of cable.

Distributed Split Network Overview

Unlike a Centralized Split architecture, a Distributed Split approach does not use centralized splitter cabinets but instead pushes the splitter further into the network with the splitters installed in a closure such as an aerial closure or pedestal as reflected in Figure 2: Typical Distributed Split.

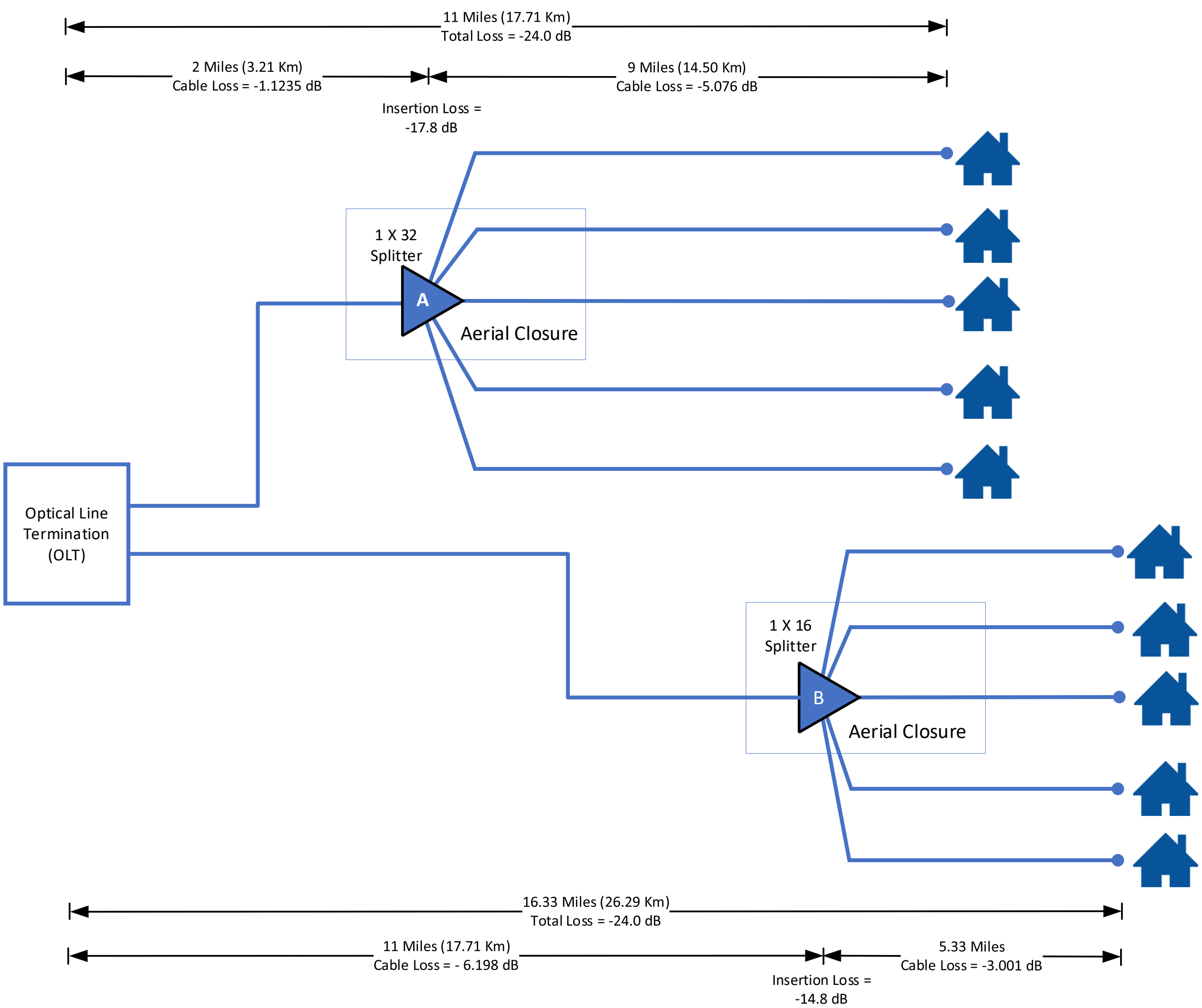


Figure 2:Typical Distributed Split

A major advantage of a Distributed Split approach is the significant reduction in cable sizes resulting in an overall reduction of CapEx to deploy on a per-home basis. Since the splitters are pushed deeper into the outside plant fiber network the number of fibers required to serve the subscribers is greatly reduced. Whereas in a Centralized Split architecture a 288-fiber cable can only support 288 subscribers, in a Distributed split architecture that same 288-fiber cable can now support between 2000-4000 subscribers depending on the split ratios in the field. Distributed Split also provides significant flexibility in reaching subscribers located farther from the OLT. As shown in Figure 2 extending a smaller 16 Port splitter deeper into the network allows the ability to reach subscribers located much further from the OLT. In the example shown in Figure 2 the distance from the OLT increases from 11 miles to over 16 miles using a Distributed Split approach.

A Distributed Split approach has a few disadvantages with the utilization of the OLT Ports being the most significant. Whereas in a Centralized Split architecture all 32 ports of the splitter and subsequent OLT port are used before a second OLT and Splitter are required, in a Distributed Split if customer 1 is in served by Splitter A and customer 2 is served by splitter B, then both OLT ports must be provisioned and activated. In a Distributed Split approach Point to Point (P2P) services such as E-LINE, E-LAN, MPLS, etc. must be allocated and planned for in the initial design which reduces flexibility. However, XGS-PON solutions which are 10Gbps synchronous are now certified by the Metro Ethernet Forum (MEF) to provide these types of services across a PON FTTx architecture. A Distributed Split Architecture requires more detailed records to assure assignments from the Multiple Services Terminal (MST) through the splitter back to the OLT Port are tracked.

Summary

Choosing the right architecture for a FTTH network is not a simple decision, it requires balancing the impact on both deployment cost and network performance and flexibility.

The advantages and disadvantages of centralized splitting and distributed splitting networks are summarized in the table below:

FTTH Splitting Types	Advantages	Disadvantages
Centralized Splitting	OLT utilization (pay as you grow)	Higher count distribution fibers
	Future proof & easy to change technology	Larger network elements in the OSP
	Monitoring & maintenance	Possibly additional infrastructure
Distributed Splitting	Lower capital expense for customer connection	More actives and more splitters
	Reduces splitter cabinet requirements	Less flexible network
	Flexibility in split ratios in serving area	Fewer monitoring & maintenance capabilities
	Maximizes Fiber Utilization	Requires OLT ports up front

The density and distance of the customer base in a Distribution Area (DA) is one of the most important deciding factors in selecting an architecture. In urban locations that have a higher density, more industry and large business customers a Centralized Split might be the best choice where P2P services as well as PON services will be utilized, and longer distances are not as much of a consideration. On the other hand, considering the flexibility and greater distances covered, a Distributed Split is a better choice for rural or less populated areas.

Infrastructure

We are defining “infrastructure” as the deployment necessary to offer services to any given area. In simple terms, this would include backbone and distribution fiber. This does not include network components, drops to the premises or any of the equipment installed at or in the home.

Backbone

The plan anticipates the following:

- The backbone will be approximately 216 miles in length.
- It is anticipated that 95% of the backbone will be aerial. This is in line with the primary spans that we have. It is a reasonable assumption, given Vermont's terrain and local knowledge, that 95% aerial will hold for the areas where primary span data was lacking, and road miles were used.
- 75% of the backbone is planned to be 144 count fiber. 25% will be 288 count.

Distribution

The plan anticipates the following:

- Distribution fiber will be approximately 1,151 miles in length.
- It is anticipated that 94.1% of the distribution will be aerial based on available primary electric spans.
- 100% of distribution fiber is modeled at 48 count understanding that fiber counts may be pushed higher or lower in some areas depending on densities and fiber allocation planning.
- The distribution per phase to be built is as follows:
  - Phase 1: 284 mi
  - Phase 2: 432 mi
  - Phase 3: 269 mi
  - Phase 4: 166 mi

Phase Schedule

	Build Start (Mo)	Miles per Month	Build Months	Build End (Mo)	Customer Launch Month
Backbone	6	25	9	14	NA
Phase 1	6	25	12	17	10
Phase 2	18	50	9	26	21
Phase 3	27	50	6	32	29
Phase 4	33	50	4	36	34

Make Ready

The business plan assumes a make ready cost of $6,500 per mile. This is one of the largest unknown variables. NRTC has completed a benchmark survey of 36 rural broadband projects and the cost of make ready ranged from less than $2,000 per mile to $12,000. NWFX will be building on multiple utility plants and the age of the poles, the existing third-party attachments, and vegetation maintenance may vary significantly. Some make ready credits may be available to NWFX. NWFX may also work to ensure that it is not bearing the cost of plant that should already be replaced. This will be a large effort and this $6,500 per mile make ready cost is one that should be monitored closely.

Infrastructure Capital Expense

The total anticipated capital expense necessary to build infrastructure necessary to offer all underserved locations in the member towns is as follows:

Infrastructure Investment Required	Unit Cost	Units	Total ($000's)
Design and Engineering	$3,153	1,367	$4,309
Project & Construction Management	$2,355	1,367	$3,219
Headend/Office Space	$551,982	0	$0
Field Network Equipment	$0	0	$0
Aerial Construction	$29,189	1,288	$37,598
Underground Construction	$67,810	78	$5,320
Contingency	5.0%		$2,522
Total Fiber Construction			$52,967

Three-Year Infrastructure Capex (000's)	Year 1	Year 2	Year 3
	$16,104	$17,983	$18,881

The average per-mile cost breakdown is as follows:

Construction Cost Detail (5 Yr)	Aerial	UG
Make Ready	$6,500	$0
Plant Labor	$13,779	$55,650
Technical Labor	$4,338	$5,431
Fiber	$2,980	$2,461
Materials	$1,363	$4,045
Technical Materials	$229	$223
Subtotal	**$29,189**	**$67,810**
Design and Engineering	$3,153	$3,153
Project & Construction Management	$2,355	$2,355
Total Capex/Mile (Home for Drops)	**$34,697**	**$73,318**

Construction Capex Metrics by Zone

The following table is infrastructure costs only. It does not include the costs of the drop.

	Miles	Passings	Yr 5 Subs	Capex ($000's)	Capex/ Home	Capex/ Sub
Backbone	216	0	0	$9,552	$0	$0
Phase 1	284	5,568	2,506	$10,531	$1,891	$4,203
Phase 2	432	12,445	5,600	$16,972	$1,364	$3,031
Phase 3	269	4,071	1,832	$10,529	$2,586	$5,747
Phase 4	166	6,092	2,741	$6,488	$1,065	$2,367
Total	1,367	28,176	12,679	$54,071	$1,919	$4,265

Drops

Take Rate

In this plan we are modeling that NWFX will build and own the drop.

Because NWFX will be accountable for the costs of drop construction, we modeled a take rate that would drive subscriber costs (and revenue). NWFX is prepared for a take rate of 45% after year five with a gradual ramp to that full take ramp.

The take rate ramp and resulting subscriber count is detailed in the table below.

	Year 1	Year 2	Year 3	Year 4	Year 5
Homes passed/covered	3,248	15,247	28,176	28,176	28,176
Residential Take Rate	22.5%	26.6%	31.9%	40.9%	45.0%
Subscribers	731	4,057	8,992	11,536	12,679

Drop Capex

When accounting for churn, which is when subscribers disconnect and/or move, we anticipate approximately 12,679 drop connections that will need to be made in the first five years. The cost to connect a home, including the drop but not the customer install (which will be the responsibility of the carrier) is anticipated to average $1,411. The associated drop capex would be as follows:

Infrastructure Investment Required	Unit Cost	Units	Total ($000's)
Fiber Drop Construction	$1,411	12,679	$17,889
Contingency	5.0%		$894
Total Customer Equip & Install			**$18,784**

Five-Year Drop Capex (000's)	Year 1	Year 2	Year 3	Year 4	Year 5
	$1,083	$4,928	$7,312	$3,768	$1,694

Total Project Capex

Taken together, the infrastructure, success-based customer drop capital, and other capex expenses totals approximately $74.8 million.

Design and Engineering	$4,309
Project & Construction Management	$3,219
Aerial Construction	$37,598
Underground Construction	$5,320
Contingency	$2,522
Total Fiber Infrastructure Construction	**$52,967**
Fiber Drop Construction	$17,889
Contingency	$894
Total Customer Equip & Install	**$18,784**
Other Capex	$1,158
Total Project Capital Costs	**$72,909**

Operational Expense

Northwest Fiberworx's business plan does include the operational expenses of running of maintaining the network. The expenses are estimates based on some industry standards and feedback from other projects.

The pole attachment fees are based on $0.90 per month per pole. We are estimating 290 feet between each pole. By the end of year four when the project would be completed, we are anticipating $262,000 annually in pole rent.

Other expenses include facilities and rent, wages, a fiber maintenance contract and contingency operating expenses.

A full 20-year financial model with significant detail has been delivered to NWFX. Below is a five-year snapshot.

Expenses ($000's)	Year 1	Year 2	Year 3	Year 4	Year 5
Facilities rent and utilities	$48	$49	$50	$51	$52
Maintenance contract	$0	$71	$136	$164	$164
Property taxes	$0	$0	$0	$0	$0
Pole Rent	$22	$114	$216	$262	$262
Wages: Project Mgt, Admin, Marketing	$390	$402	$414	$471	$508
Contingency expenses	$96	$96	$96	$96	$96
Capitalized Wages	($195)	(201)	($86)		
Total Operating Expenses	**$361**	**$531**	**$825**	**$1,044**	**$1,082**

Revenue

Competitive Information

The following table, while not inclusive of all service types and providers, does capture the larger competitors offering a real broadband service in Vermont.

PROVIDER	TYPE	SERVICE SPEED (MB)	MONTHLY PRICE
Consolidated	FTTH	• 20/5 • 40/10 • 80/20 • 100/40 • 1G/1G	• $60.99 • $75.99 • $95.99 • $105.99 • $129.99
Green Mountain Access	FTTH	• 100/100 • 500/500 • 1G/1G	• $76.95 • $91.95 • $103.95
Comcast	CATV	• 25/5 • 100/10 • 300/30 • 600/60 • 1G/1G	• $49.95 + $14 wireless gateway rental • $77.95 • $97.95 • $102.95 • $107.95
Spectrum	CATV	• 100/10 • 400/20 • 1G/35	• $69.99 + $5 modem rental • $94.99 • $129.99
Stowe Communications	CATV	• 7/1.5 • 25/5 • 75/15 • 100/20	• $49.95 + $10 modem rental • $79.95 • $115.95 • $125.95

The average price for 100 Mbps is $91.37. Comcast and Spectrum offer 100 Mbps at considerably less, $77.95 and $69.99 respectively. The average price for gigabit is $119.57 and, in this case, the average cost for this service provided by Comcast and Spectrum is in line with the other providers.

Speed	Total Average	Comcast/Spectrum
100 Mbps	$91.37	$75
Gigabit	$119.57	$118.97

Business Plan Revenue and Grant

NWFX's plan for an open access network does call for a specific average revenue per unit to be modeled but the CUD will clearly need to generate sufficient revenue to cover the cost of any debt incurred. NWFX will need to take on debt to cover the costs of the network that will not be covered by grant. While the exact amount of grant is to be determined, the plan is assuming $45,800,000 of grant money to be made available for the construction of this project. The balance would be borrowed at 3%.

This would require that NWFX generate in the neighborhood of $3.1M-$3.3M annually in revenue so that the business could sustain itself over the two decades without having to continue to borrow money.

This revenue would have to be generated in the foreseeable future by residential and small business revenue. It would be generated by one or more carriers on the NWFX network. It is possible that dark fiber leases and enterprise level services supported by NWFX itself could contribute to this revenue picture, but a reliable path to these services cannot be counted on or modeled. In addition, offering them would require an investment in network assets and additional human resources.

Financial Summary

Metrics

The health or feasibility of this business plan is somewhat subjective and will have to be clearly understood and analyzed by NWFX to determine that it meets an acceptable level.

It should be clearly understood that the metrics listed below and included in further detail in the financial model provided to NWFX are not those that an investor-owned organization would find attractive. They are much more in line with the metrics of a community-minded organization committed to delivering broadband where it otherwise would not exist. Still, the plan is cognizant of the fact that the grant expected by NWFX does not cover the entire effort involved and the CUD will need to be in a favorable position to raise more capital.

Some of the metrics included in NWFX's financial model are highlighted below and are based on the CUD generating approximately $3,150,000 in revenue annually.

- EBITA positive: year 3
- Debt service ratio (year 7): 1.6
- Modeled loan rate: 3.0%
- Project IRR: 4.1%

Project Risks

While Northwest Fiberworx and NRTC worked to ensure that the best possible data was used for the basis for the NWFX Business Plan, there is the potential that unforeseen events could impact the results negatively.

Aerial vs. Underground

Aerial fiber construction is projected to be a large majority of the construction. If it turned out that plant or other conditions led to a significantly higher number than the 78 miles of underground that are expected to be built, the expense of underground construction could escalate the expected necessary capital quickly.

Materials and Contractors

Fiber materials and construction contractors are being stretched thin and the amount of anticipated fiber that will be built both regionally and nationally for the foreseeable future will only put more stress on these resources. NWFX would have to be proactive in securing both materials and crews that would be able to start the project and maintain a steady and continuous work-plan for the duration of the project.

Revenue

The revenue in this model is solely generated by carriers joining an open access network and generating the sufficient revenue to keep NWFX whole and the business enduring. NWFX will have to be confident that it will be attracting sufficient service providers that will generate the revenue NWFX needs in order to sustain itself. Those service providers will need to offer packages that subscribers in Northwest Vermont find attractive and the service level provided would have to encourage subscriber retention.

The annual revenue projections of $3.1M-$3.3M included in this plan should be considered the floor. Should revenues fall below these levels, the CUD would struggle to meet its commitments.

Make Ready

Finally, there is a great deal unknown about make ready. This will require negotiation and coordination between NWFX and the various power companies it works with. Based on many other projects, the $6,500 modeled per mile for make ready in the NWFX plan is significant. Still, this is a variable that could increase the capital expense necessary to build this project.

Delays in the completion of make ready work would also present challenges to the success of the project.