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Eastern Shore of Virginia Broadband Authority (ESVBA) Broadband Rate Review

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1. Executive Summary

CTC surveyed regional and national network providers to develop a comparative analysis of the rates charged by the Eastern Shore of Virginia Broadband Authority (ESVBA) for Ethernet and dedicated Internet services. This report provides an analysis of the pricing information we received from a large subset of the providers that we surveyed. We also analyzed the pricing that ESVBA offers for wireless Internet service providers (WISPs) through an Ethernet virtual private line (EVPL) circuit. In addition, we did a high-level review of ESVBA's financial statements and offered comments regarding the sustainability of the operations.

1.1 Pricing Compared

The ESVBA provides four types of services:

- Ethernet Local Area Network (ELAN) and Ethernet Line or point-to-point Ethernet (ELINE), at speeds of 1 Mbps to 10 Gbps
- Dedicated Internet (also known as Dedicated Internet Access or DIA) at speeds of 1 Mbps to 10 Gbps
- Synchronous Optical Network (SONET) services
- EVPL WISP services

For this analysis, we compared the pricing for Ethernet (ELAN and ELINE) and DIA services that ESVBA offers at 10 Mbps, 20 Mbps, 50 Mbps, 100 Mbps, 1 Gbps, and 10 Gbps.

As these comparisons illustrate, pricing varies greatly among markets and even among carriers in the same market. Pricing is route-specific and location-specific, and can sometimes appear arbitrary.

There is generally a difference between private, commercial networks, and those subsidized by state-sponsored funding or non-profits. Commercial pricing is based on a mix of factors including market competition, market demand, and the cost of building fiber. Providers with similar geography and population density often have similar pricing.

Non-commercial pricing takes the same factors into account but with less or no margin. In some cases, customers are other network providers or community anchor institutions (CAIs) that operate on the open access network. For example, some of the higher education networks around the country base their pricing on a construction and operations cost recovery model.

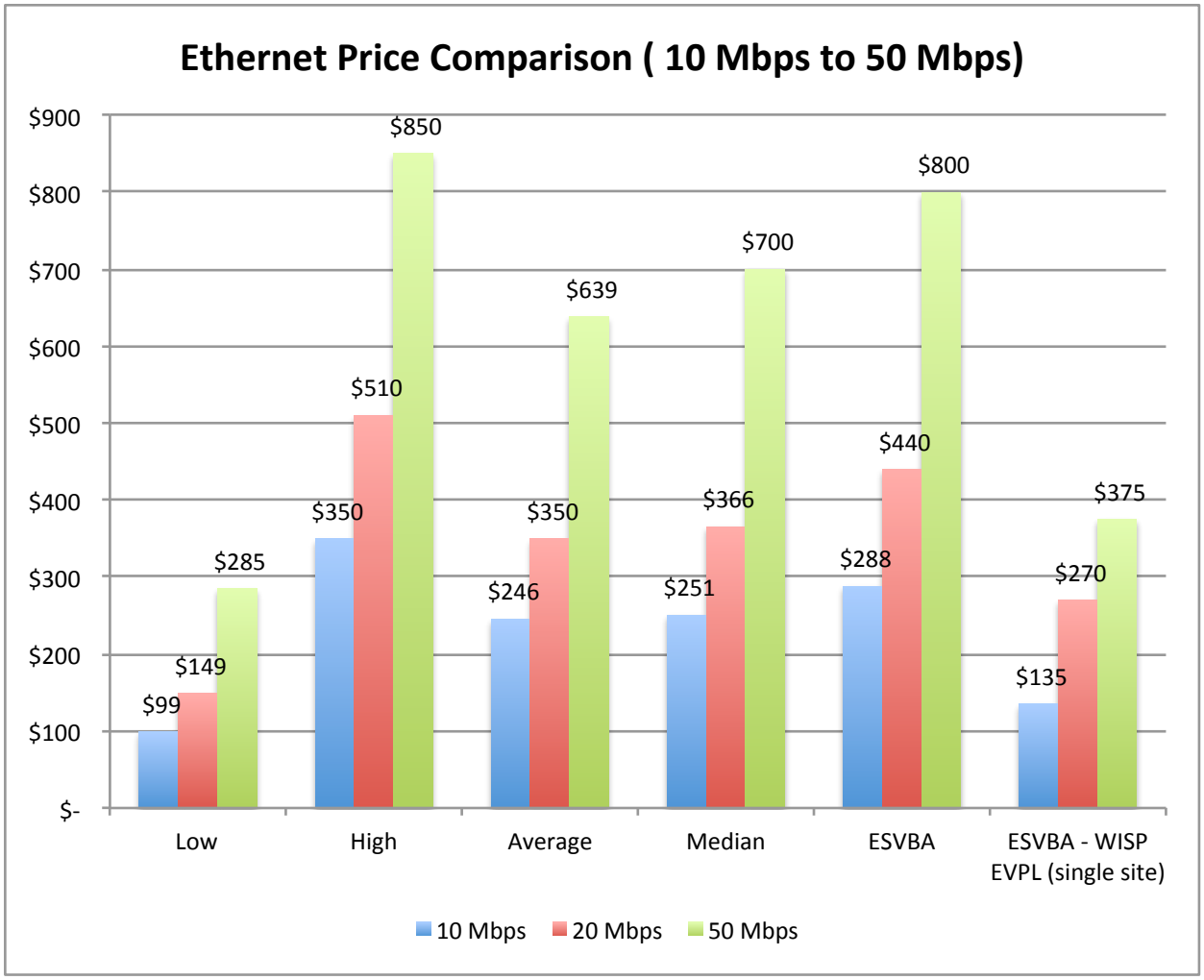
1.2 Summary of Monthly Pricing Comparison

In general, ESVBA's pricing is on par with similar networks in the region. For some services, the pricing is on the higher-end of the ranges in the comparison. This may be a result of several factors such as a provider having lower costs due to their network's location and the potential that the organization receives other operational support. For the most part, however, ESVBA's pricing falls in the middle of the ranges that we have seen.

As seen in Figure 1, ESVBA is not the lowest price provider for 10 Mbps, 20 Mbps, or 50 Mbps Ethernet (ELAN or ELINE) services, but is priced in the middle-range. We made the following observations while comparing ESVBA's monthly recurring charges (MRC) pricing at the specific speeds mentioned above over a 60-month term (discussed in detail in Section 2):

- Pricing for 10 Mbps Ethernet service ranges from $99 to $350 with an average of $261. ESVBA's pricing of $288 is the median of the examples.
- Pricing for 20 Mbps Ethernet service ranges from $149 to $510 with an average of $361 and a median of $370. ESVBA's pricing is $440.
- Pricing for 50 Mbps Ethernet service ranges from $285 to $850 with an average of $676. ESVBA's pricing of $800 is the median. ESVBA's pricing is similar to the providers closest to the Eastern Shore and also on the high end of the range.
- The WISP (Wireless Internet Provider) EVPL (Ethernet Virtual Private Line) service from ESVBA offers a lower cost alternative to an Ethernet (ELAN or ELINE) service. It is a service with allows multiple sites to share a committed interface rate (CIR) at the network edge. The effective per site monthly fee is dependent upon the number of sites connected. To compare it with Ethernet services, we have presented the ESVBA WISP EVPL pricing for the aggregated bandwidth at the Customer Edge User Network Interface (CE UNI) at the Service Provider's POP. As sites are added the average price per site will decrease. For comparison, the single site pricing is:
    - $135 for a 10 Mbps connection ($100 plus $3.5 per Mbps)
    - $270 for a 20 Mbps connection ($200 plus $3.5 per Mbps)
    - $375 for a 50 Mbps connection ($200 plus $3.5 per Mbps)

Figure 1: Ethernet Monthly Price Comparison (10 Mbps, 20 Mbps, and 50 Mbps)

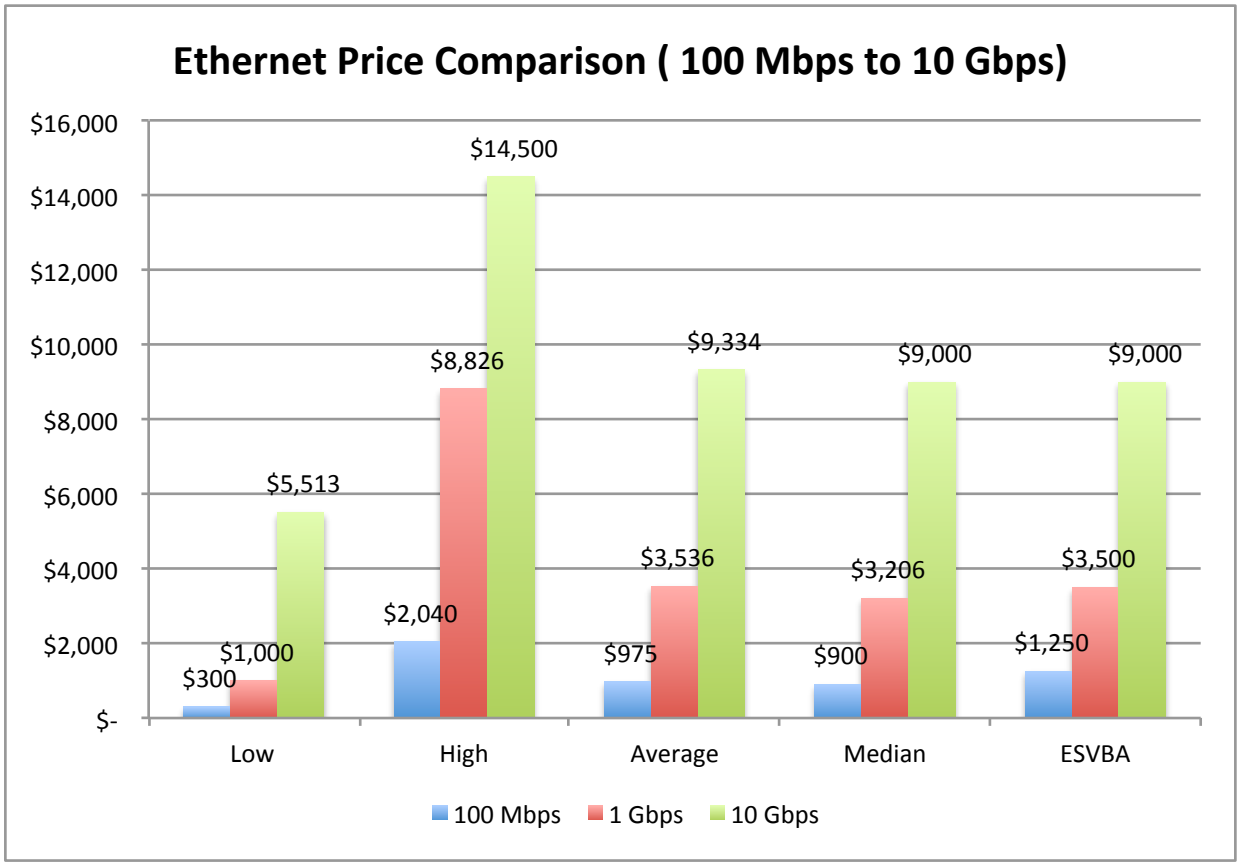


As seen in Figure 2, ESVBA pricing tends to be in the higher range for 100Mbps, 1 Gbps, and 10 Gbps Ethernet, but in the middle for public sector providers. For 10 Gbps, ESVBA is the median price example.

- Pricing for 100 Mbps Ethernet service ranges from $300 to $2,040 with an average of $875 and a median of $900. ESVBA's pricing of $1,250 is on the high-end of the range.
- Pricing for 1 Gbps Ethernet service ranges from $1,000 to $8,826 with an average of $3,536 and a median of $3,206. ESVBA's pricing is at $3,500. While this pricing is high compared to commercial examples, it is in the middle of the range for the public sector networks.
- Pricing for 10 Gbps Ethernet service ranges from $5,513 to $14,500 with an average of $9,334. ESVBA's pricing of $9,000 is the median.

- We have not shown the WISP EVPL prices in Figure 2 since the calculation with 1 Gbps is deceiving when compared to the Ethernet pricing [1]. For example, the 1 Gbps CE UNI price is $4,100 vs. the $3,500 Ethernet price, which implies a higher price. However the "net" price of serving a mix of 10 Mbps, 20 Mbps, 50 Mbps, and 100 Mbps WISP EVPL sites feeding a 1 Gbps CE UNI is lower than configuring with an Ethernet alternative.

Figure 2: Ethernet Monthly Price Comparison (100 Mbps, 1 Gbps, and 10 Gbps)



As seen in Figure 3 ESVBA is not the lowest price provider for 10 Mbps, 20 Mbps, or 50 Mbps DIA[2], but is priced in the mid-range at 10 Mbps and 20 Mbps, but tends to be high for 50 Mbps.

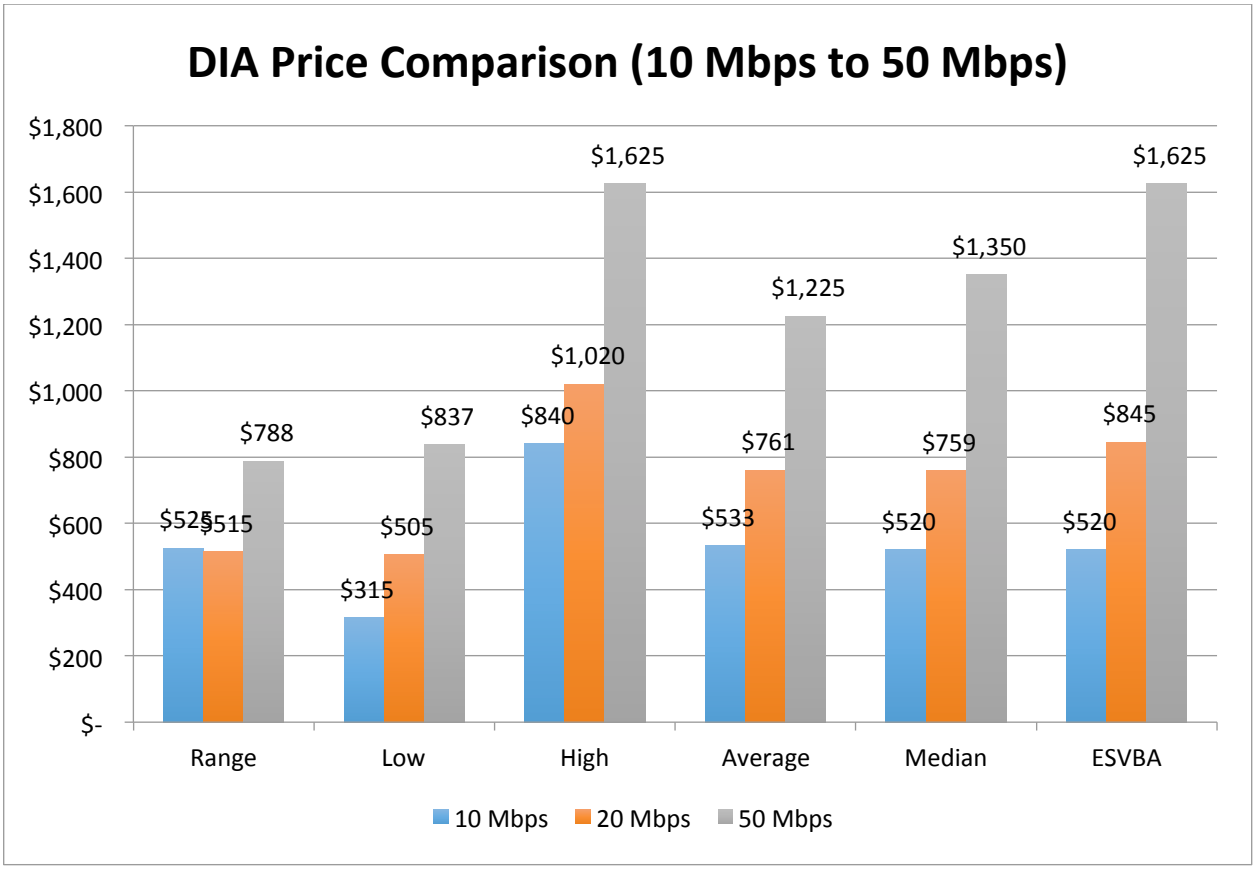
- For DIA service at 10 Mbps, pricing ranges from $315 to $840 with an average of $533. ESVBA's pricing of $520 is the median.
- For DIA service at 20 Mbps, pricing ranges from approximately $505 to $1,020 with an average of $761 and a median of $759. ESVBA's pricing is $845.

[1] 10 Gbps EVPL service is not offered.

[2] Prices include a circuit and DIA.

- For DIA service at 50 Mbps, pricing ranges from approximately $837 to $1,625 with an average of $1,245 and a median of $1,359. ESVBA's pricing of $1,625, the highest price point.

Figure 3: DIA Monthly Price Comparison (10 Mbps, 20 Mbps, and 50 Mbps)



As seen in **Figure 4**, ESVBA is on the high-side provider for 100 Mbps and 1 Gbps DIA[3] service. However, ESVBA is priced in the mid-range for the 10 Gbps service.

- For DIA service at 100 Mbps, pricing ranges from $1,360 to $2,275 with an average of $1,872 and a median of $1,972. ESVBA's pricing of $2,275 is the highest price (along with Maryland Broadband Cooperative).

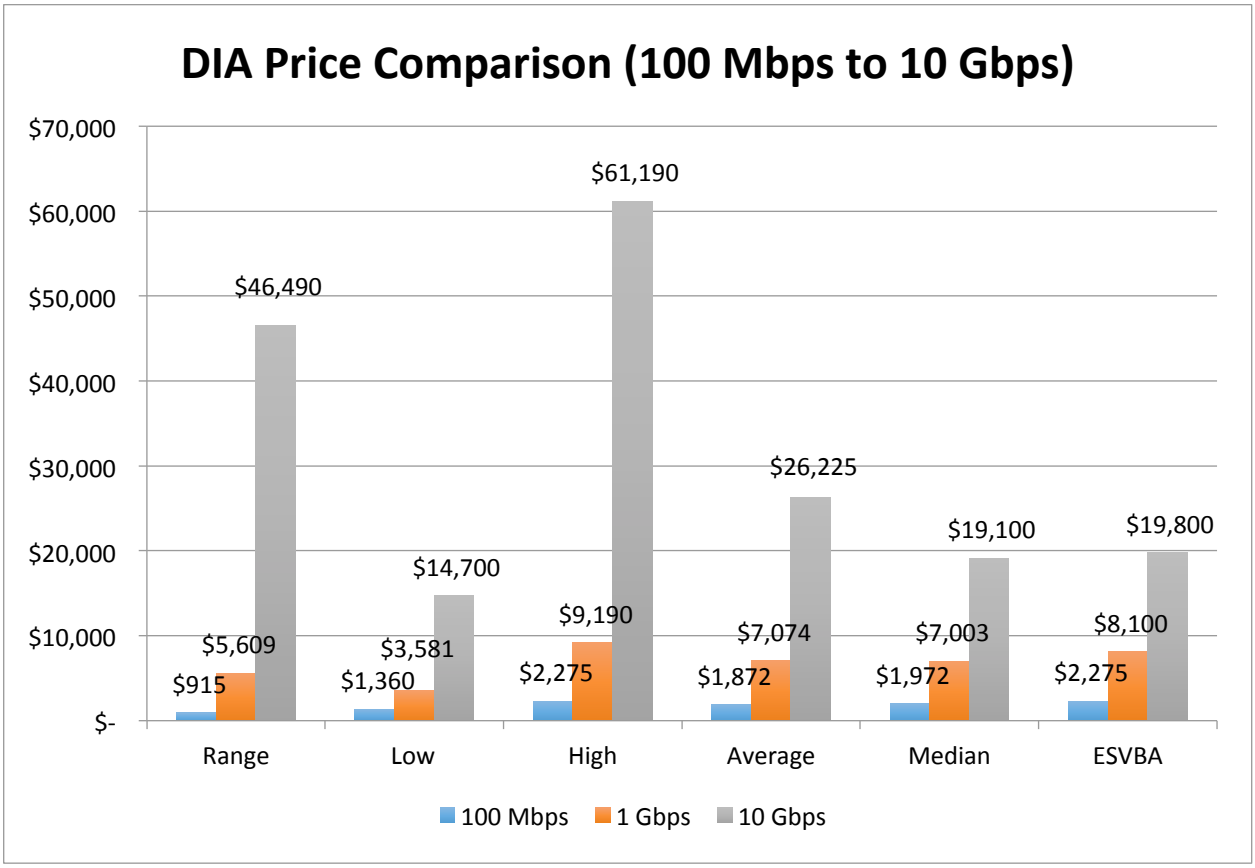
- For DIA service at 1 Gbps, pricing ranges from $3,581 to $9,190 with an average of $7,074 and a median of $7,003. ESVBA's pricing is $8,100 (comparable to Maryland

[3] Prices include a circuit and DIA.

Broadband Cooperative). In this case, the pricing examples from the commercial sector are around $6,000, whereas the public sector has higher pricing.

- For DIA service at 10 Gbps, pricing ranges from $14,700 to $61,190 with an average of $26,225 and a median of $19,100. ESVBA's pricing of $19,800 is in-line with similar providers.

Figure 4: DIA Monthly Price Comparison (100 Mbps, 1 Gbps, and 10 Gbps)



Tables 1 to 4 summarize the prices for bandwidth for the selected services on a per-month basis (typically for a 60-month term) along with any non-recurring charges (NRC).

Table 1: Summary of Lower Data Rate Ethernet Pricing Examples

Provider	Ethernet Monthly Circuit Pricing			NRC or Installation Fees	Other Pricing Structure
	10 Mbps	20 Mbps	50 Mbps		
Public sector providers					
Axia Massbroadband123	$99	$149	$285	Additional Fees	
ESVBA	$288	$440	$800		
Mid Atlantic Broadband	$340	$510	$850		
Maryland Broadband Cooperative	$340		$850		
Nelson County Broadband Authority		$250			
networkMaryland	$200	$370	$846	$500	
Page County Broadband	$213	$361	$502		
Roanoke Valley Broadband Authority	$350	$450	$600	$500	

Table 2: Summary of Higher Data Rate Ethernet Pricing Examples

Provider	Ethernet Monthly Circuit Pricing			NRC or Installation Fees	Other Pricing Structure
	100/250 Mbps	1 Gbps	10 Gbps		
Public sector providers					
Axia Massbroadband123	$475	$1,200	$6,500	Additional Fees	
ESVBA	$1,250	$3,500	$9,000		
CENIC	case-by-case	case-by-case	case-by-case		
ICN	$469	$1,083			
KanREN					$84 per Mbps per year for Ethernet connectivity or $7 per Mbps per year
Maryland Broadband Cooperative	$1,275 to $2,040	$4,950	$9,950		
Mid-Atlantic Broadband (regional network)		$5,950 to $7,000		$750	
Mid-Atlantic Broadband (long-haul POP)		$5,100 to $6,000	$12,325 to $14,500	$1,250	
Nelson County Broadband Authority	$300 to $800	$1,000 to $1,660			
networkMaryland	$1,476	$8,826		$500	
OARnet	$660 to $1,000	$1,190 to $1,750		Additional Fees	
Page County Broadband	$757 to $1,275				
Roanoke Valley Broadband Authority	$900	$4,100		$500	
Commercial Providers					
Comcast		$1,250			
Zayo		$2,340 to $3,206	$5,513 to $7,553		

Table 3: Summary of Lower Data Rate DIA Pricing Examples

Provider	DIA Monthly Circuit Pricing			NRC or Installation Fees	Other Pricing Structure
	10 Mbps	20 Mbps	50 Mbps		
Public sector providers					
ESVBA	$520	$845	$1,625		
Maryland Broadband Cooperative	$340 plus Internet rate of $10 per Mbps		$850 plus Internet rate of $10 per Mbps		
networkMaryland	$165 plus physical port connection of $150 for on-net locations	$355 plus physical port connection of $150 for on-net locations	$705 plus physical port connection of $150 for on-net locations		Subscriber must have a physical port connection before ordering Internet services (100 Mbps at $650 and 1 Gbps at $1,000 for off-net locations and $150 for on-net locations)
OARnet	Ethernet plus Internet rate of $18 per Mbps	Ethernet plus Internet rate of $18 per Mbps	Ethernet plus Internet rate of $16 per Mbps	Additional Fees	Ethernet rates range from $660 to $1,000 (term based) for 100 Mbps and $1,190 to $1,750 (term based) for 1 Gbps
Roanoke Valley Broadband Authority	$550	$672	$837	$500	

Table 4: Summary of Higher Data Rate DIA Pricing Examples

Provider	DIA Monthly Circuit Pricing			NRC or Installation Fees	Other Pricing Structure
	100 Mbps	1 Gbps	10 Gbps		
Public sector providers					
ESVBA	$2,275	$8,100	$19,800		
ICN	$1,983	$9,188			
Maryland Broadband Cooperative	$1,275 plus Internet rate of $10 per Mbps	$4,950 plus Internet rate of $3 per Mbps			
networkMaryland	$1,230 plus physical port connection of $150 for on-net locations	$7,355 plus physical port connection of $150 for on-net locations			Subscriber must have a physical port connection before ordering Internet services (100 Mbps at $650 and 1 Gbps at $1,000 for off-net locations and $150 for on-net locations)
OARnet	$660 to $1,000 plus Internet rate of $13 per Mbps	$1,190 to $1,750 plus Internet rate of $8 per Mbps	Port pricing plus Internet rate of $6 per Mbps	Additional Fees	Ethernet rates range from $660 to $1,000 (term based) for 100 Mbps and $1,190 to $1,750 (term based) for 1 Gbps
Roanoke Valley Broadband Authority	$1,360	$5,687		$500	
Commercial providers					
Comcast			$14,700		
Cox Communications		$5,965	$18,400	$325 to $625	
Verizon		$6,500			
Zayo		$3,581 to $5,968	$17,036 to $28,393		

1.3 Review of ESVBA Financial Statements

As indicated above, ESVBA is neither the lowest nor the highest cost provider when compared to providers serving similar territories. From our review, we do not see a compelling reason to lower prices at this time. ESVBA has lowered prices three times in the last three years and ESVBA pricing is in-line with similar providers in the region. It is also critical that ESVBA maintains a solid financial position to support continued network expansion and equipment

replenishments. Furthermore, we have not heard any discussions or seen any evidence that ESVBA is losing opportunities because of pricing. The price pressure seems to be based on provider requests. Just as ESVBA is continuing to seek ways to lower operational costs, ISPs that acquire ESVBA services are also seeking to lower costs and will continue to ask. ESVBA does not need to lower costs nor do the requests imply price reductions are required. Rather than responding by lowering prices based on customer inquiries, a better measure would be to examine:

- The retention of existing connections and customers
- Market acceptance as network is expanded
- Cash flow of the enterprise

Market acceptance and profitability are the best measures to judge pricing levels by.

1.3.1 Existing Situation

ESVBA is in a good fiscal position today. ESVBA carries little or no debt on over $10 million in assets and is maintaining cash flow.[4] The cash flow sustainability is not just on the operation costs, rather, the operating budget includes network replenishments (electronics upgrades and replacements) and network expansion as well. This does not, however, mean ESVBA will be able to continue as is with no operational or marketing adjustments.

ESVBA's existing situation is as follows:

- Wholesale customers account for approximately 70 percent of revenues.
    - We suspect the enterprise[5] customer base (direct and wholesale) growth has slowed and is limited to areas where network extensions are added.
    - WISPs and other ISPs are receiving interest, but ISPs will need to make investments in last-mile fiber or the addition of wireless access points in order to expand their potential customer base.
- We suspect that growth in government, education, and medical customers (30 percent of revenues) is limited to areas where network extensions are added.

[4] Based on the Income Statement (May 2016 to Oct 2016), Cash Flow Statement (May 2016 to Oct 2016), and Balance Sheet (End of Nov 2016) supplied by ESVBA to CTC.

[5] A large data user requiring a high-end data product that has service level agreements (SLAs) and other performance attributes (see Appendix A).

- Almost 50 percent of ESVBA's operating costs are labor-based with expected annual increases. ESVBA runs a lean staff and leverages contractors to keep fixed costs low. It will be difficult to reduce these costs.

- Internet access and other direct costs account for almost 30 percent of operating expenses. We suspect these costs will drop over time, perhaps offsetting increases in labor costs.

- To maintain the network, $5.475 million is budgeted[6] over the next seven years for equipment replenishments (electronics, battery and vehicle replacements and upgrades).

- ESVBA has indicated plans[7] to add $6.659 million in network expansions and added redundancy over the next seven years. This includes a $4.4 million expansion to Tangier Island. This does not include the identified potential investments of $3.6 million for fiber expansion and $600,000 in tower additions.

1.3.2 Market Expansion

The current state of ESBVA's network and assets leads to a situation in which customers are expecting drops in service fees while expenses increase. With no action, this situation will likely result in a decline of margins and an erosion of cash flow. Expanding revenue and margins will require strategic expansion of ESVBA's footprint and services offered.

When looking at expansion opportunities, it is critical to examine the market potential on a case-by-case basis. Understanding the demand, costs, and competition is critical. It is also important to recognize and understand differences in customer expectations and needs as services expand to smaller businesses and possibly residences. For example, expansion into the residential and small business market:

- Greatly increases the total cost to connect the customer base. Although on a per-unit basis the costs are lower than an enterprise customer, the number of passings is greater.

- Shifts customer service support from service maintenance with SLAs to a technical "help desk" troubleshooting customer computer and network issues.

- Returns smaller margins and revenues per customer, as they are much lower than the more profitable enterprise and wholesale customers.

[6] Based on the seven-year operating budget supplied by ESVBA to CTC.
[7] Based on the seven-year operating budget supplied by ESVBA to CTC.

- Requires a more aggressive sales and marketing effort.
- May place ESVBA in competition with existing wholesale customers.

We also suggest taking caution when looking at other public FTTP deployments. When looking at another project's reported financials, it is critical to understand the business model and financial structures *unique to that project*. For example, with many municipal FTTP deployments, the municipal electric utility requires fiber connections that justify capital and operating expenses to be covered by the electric utility.

This is not to say that ESVBA should not consider expansion into the small business and residential markets with FTTP or other technology. We advise caution and careful consideration of each opportunity on a case-by-case basis.

2. Examples of Pricing

We obtained pricing from several non-commercial (public sector or non-profit) and commercial networks. As the primary point of pricing comparison, we have listed ESVBA's pricing.

2.1 ESVBA's Pricing

ESVBA offers Ethernet (ELAN and ELINE) services at the following monthly costs:[8]

Table 5: ESVBA ELAN and ELINE Rates (Selected Speeds)[9]

Speed	MRC (60-Month Term)	MRC (36-Month Term)	MRC (24-Month Term)	MRC (12-Month Term)
10 Mbps	$288	$331	$361	$397
20 Mbps	$440	$506	$550	$607
50 Mbps	$800	$920	$1,000	$1,104
100 Mbps	$1,250	$1,380	$1,500	$1,656
1 Gbps	$3,500	$4,025	$4,375	$4,830
10 Gbps	$9,000	$10,350	$11,250	$12,420

ESVBA offers Dedicated Internet services at the following rates:

[8] Monthly recurring charges are based on existing ESVBA "Lit Buildings" on the Eastern Shore of Virginia.
[9] http://www.esvba.com/services/, accessed October 2016.

Table 6: ESVBA DIA Rates (Selected Speeds)[10]

Speed	MRC (60-Month Term)	MRC (36-Month Term)	MRC (24-Month Term)	MRC (12-Month Term)
10 Mbps	$520	$598	$650	$718
20 Mbps	$842	$972	$1,056	$1,166
50 Mbps	$1,625	$1,869	$2,031	$2,243
100 Mbps	$2,275	$2,616	$2,844	$3,140
1 Gbps	$8,100	$9,315	$10,125	$11,178
10 Gbps	$19,800	$22,770	$24,750	$27,324

In addition, ESVBA applies NRC on an individual basis for installation costs, constructions costs, equipment costs, and network capacity. The minimum NRC for service to a new location is $500.[11]

2.2 Axia MassBroadband 123

Axia MassBroadband 123 provides an open-access network in rural Massachusetts. The MRC for Ethernet service is as follows:

- 10 Mbps at $99
- 20 Mbps at $149
- 50 Mbps at $285
- 100 Mbps at $475
- 1 Gbps at $1,200
- 10 Gbps at $6,500

There are additional NRC such as installation fees which vary case-by-case. The port or VPN configuration changes are priced at $50 per change.[12]

2.3 Corporation for Education Network Initiatives in California (CENIC)

The Corporation for Education Network Initiatives in California (CENIC) network, called CalREN, offers services to research and education institutions in the state. The fees charged by CENIC for its CalREN-DC service for faculty, students, and staff at educational institutions are based on

[10] http://www.esvba.com/services/, accessed October 2016.
[11] When the ESVBA is required to extend/expand its network to provide service to a customer/end user, the NRC is calculated using the Total Construction Costs (TCC), the MRC, and the Term of the contact.
[12] www.axiamassbroadband123.com/Portals/16/MB123%20Pricing.xls, accessed November,2016

the bandwidth of the connection to the backbone. These fees for usage by new CalREN associates are the following:

Table 7: CalREN-DC Bandwidth Fees[13]

Bandwidth	Annual Fee	Monthly Fee (reference only)	Bandwidth Fee per Month per Mbps (reference only)
50 Mbps	$52,000	$4,330	$86.60
100 Mbps	$56,000	$4,670	$46.70
155 Mbps	$59,000	$4,920	$31.74
250 Mbps	$65,000	$5,420	$21.68
500 Mbps	$82,000	$6,830	$13.66
1 Gbps	$113,000	$9,420	$9.42

The costs of equipment and circuits to connect to the CalREN backbone are additional fees. The connectivity fees to the high-performance research network service called CalREN-HPR are $340,000 per year from 1 Gbps to 10 Gbps.[14]

2.4 KanREN

The Kansas Regional Education Network (KanREN) provides connectivity services to its members but does not sell commercial Internet service by itself. All KanREN connectivity includes access to the KanREN network, as well as regional and national R&E networks, such as Internet2 and US UCAN. Connections are priced at an individual case basis. The membership fee is $500 per year.

The fee for network use is $84 per Mbps per year or $7 per Mbps per month[15] for aggregated bandwidth. Members that host the backbone are charged a class-wide cost recovery fee. In addition, infrastructure fees are determined by the hardware KanREN places at the member site and a percentage of core network equipment cost recovery/depreciation which varies from $20,000 per year for backbone colocation to $1,700.[16]

[13] Fees are from 2015
[14] http://www.cenic.org/page_id=185/, accessed January 14, 2015
[15] KanREN does not sell commercial Internet service by itself. All KanREN connectivity includes access to the private, advanced-services KanREN network, as well as regional and national R&E networks, such as Internet2 and US UCAN.
[16] https://www.kanren.net/membership/rates-fees/, accessed November 14, 2016

2.5 Illinois Century Network (ICN)

The Illinois Century Network (ICN) offers broadband services at speeds from 10 Mbps[17] to 1 Gbps. The MRC with port fee included is:

- $1,983.33 for 200 Mbps service (includes Internet)
- $4,833.33 for 500 Mbps service (includes Internet)
- $9,188.67 for 1 Gbps service (includes Internet)

ICN also offers point-to-point Ethernet for a monthly price per endpoint. These are priced at:

- $469.33 for 200 Mbps service
- $1,083.33 for 500 Mbps service.

There are no installation fees or NRC with the above services.

2.6 Mid-Atlantic Broadband Cooperative (MBC)

Mid-Atlantic Broadband Cooperative (MBC) offers dedicated bandwidth from 10 Mbps to 10 Gbps in eastern Virginia. MBC has a flat-rate pricing model for all optical transport services, using SONET/TDM, Wavelength and Ethernet connections. The pricing for relevant bandwidths for Ethernet connectivity within the regional MBC footprint for on-net facilities or locations with minimal connectivity capital costs is provided in Table 8 below. MBC's standard contract terms are 24 months. They offer a 10 percent discount for a 36-month contract and a 15 percent discount for a 60-month contract.

Table 8: Mid-Atlantic Broadband Regional Pricing

Connection	NRC	MRC (24-Month Term)	MRC (60-Month Term)
10 Mbps	$750	$400	$340
20 Mbps	$750	$600	$510
50 Mbps	$750	$1,000	$850
100 Mbps	$750	$1,500	$1,275
500 Mbps	$750	$4,500	$3,825
1 Gbps	$750	$7,000	$5,950
10 Gbps	ICB[18]	ICB	ICB

[17] We requested pricing details for lower speed services.

[18] Individual case basis (ICB).

The pricing for relevant bandwidths for connectivity locations within the MBC regional network to an MBC long-haul market point-of-presence (POP) is provided in Table 9 below. It does not include costs associated with cross-connects at the POP.

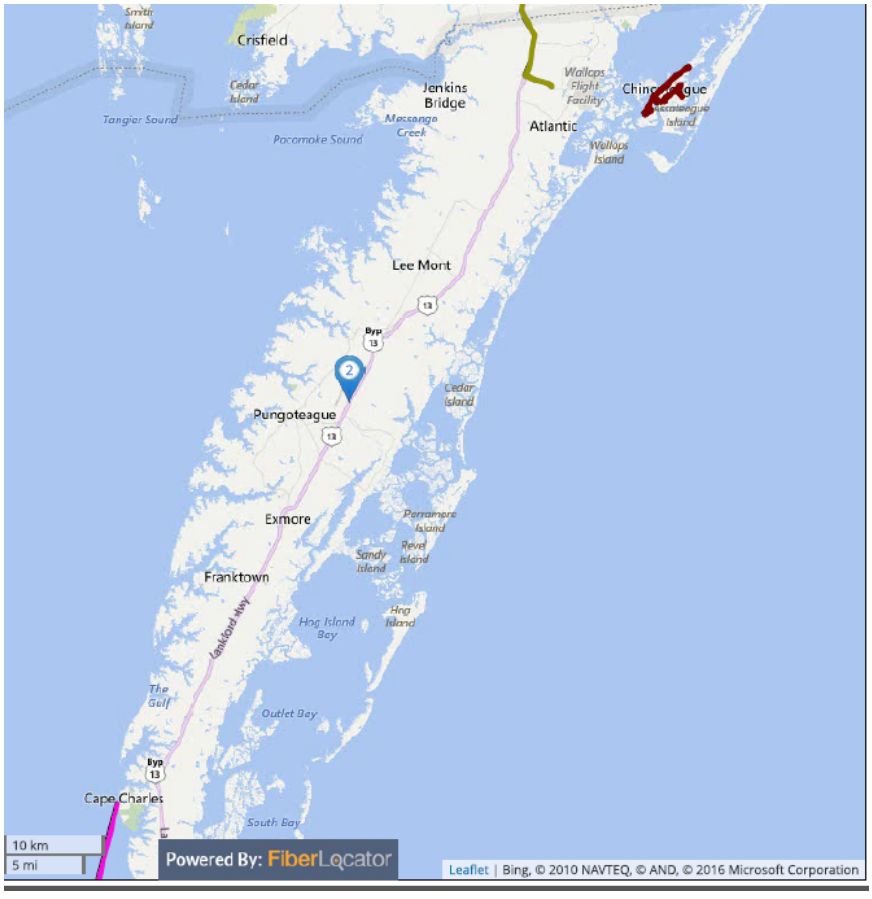
Table 9: Mid-Atlantic Broadband Regional to Long-Haul POP Pricing

Connection	NRC	MRC (24-Month Term)	MRC (60-Month Term)
500 Mbps	$1,250	$4,750	$4,038
1 Gbps	$1,250	$6,000	$5,100
10 Gbps	$1,250	$14,500	$12,325

2.7 Maryland Broadband Cooperative

The Maryland Broadband Cooperative operates in rural Maryland with approximately 70 members. The network extends into the Eastern Shore region as seen in the figure below (Maryland Broadband Cooperative network fiber is in maroon).

Figure 5: Network Providers in the Eastern Shore Region



Maryland Broadband Cooperative offers its members (who provide last mile services) transport (shown in Table 10) and Internet services. [19]

Table 10: Maryland Broadband Cooperative Transport Services Pricing (Selected Speeds)

Bandwidth	MRC			
	12 Month	24 Month	36 Month	60 Month
10 Mbps	$448	$400	$360	$340
50 Mbps	$1,120	$1,000	$900	$850
100 Mbps	$1,680	$1,500	$1,350	$1,275
200 Mbps	$2,240	$2,000	$1,800	$1,700
250 Mbps	$2,688	$2,400	$2,160	$2,040
500 Mbps	$5,040	$4,500	$4,050	$3,825
1 Gbps	$6,840	$6,000	$5,300	$4,950
10 Gbps	$13,960	$12,500	$11,550	$9,950
40 Gbps	ICB	ICB	ICB	ICB
100 Gbps	ICB	ICB	ICB	ICB

Internet services are priced on a case-by-case basis. Pricing for bandwidth up to 100 Mbps speeds is $10 per Mbps and above; 100 Mbps to 500 Mbps costs $7 to $10 per Mbps; and the cost is $3 to $5 per Mbps for 500 Mbps to 1 Gbps speeds.

2.8 networkMaryland

The State of Maryland's Department of Information Technology operates a statewide network called networkMaryland. The network offers maximum aggregate bandwidth to meet a variety of needs ranging from a monitored network connection to Layer 2 circuits and Internet services.

Below is pricing for a Layer 2 circuit, Internet services and a monitored EVPL circuit (only available in certain locations).[20]

[19] Pricing provided directly by entity via email November 2016
[20] http://doit.maryland.gov/support/Documents/nwmd_gettingconnected/nwmd2016Rates.pdf, accessed October 2016

Table 11: networkMaryland Layer 2 Circuit

Connection	MRC	NRC
10 Mbps	$200	$500
20 Mbps	$370	$500
50 Mbps	$846	$500
100 Mbps	$1,476	$500
1 Gbps	$8,826	$500

Table 12: networkMaryland Internet Service

Bandwidth	MRC	Bandwidth Fee (per month per Mbps) – for reference only	Other	NRC
10 Mbps	$165	$16.50	Subscriber must have a physical port connection before ordering Internet services (100 Mbps at $650 and 1 Gbps at $1,000 for off-net locations. $150 for on-net locations)	$500
20 Mbps	$315	$15.75		$500
50 Mbps	$705	$14.10		$500
100 Mbps	$1,230	$12.30		$500
500 Mbps	$4,455	$8.91		$500
1 Gbps	$7,355	$7.36		$500

Table 13: networkMaryland Physical Port Connection and Monitoring – EVPL Circuit – Off Net (EVC Fees and Port Fees)

Connection	MRC	NRC
100 Mbps	$1,510	$200
200 Mbps	$2,050	$200
500 Mbps	$3,550	$200

2.9 Nelson County Broadband Authority

Nelson County Broadband Authority leases its fiber network at local access rates (i.e., rates for providers to utilize its network for transport to an end user) as shown in Table 14.[21] The NRC incurred with the installation of the fiber drop and optical network terminal (ONT) are paid by the customer.

[21] http://www.nelsoncounty-va.gov/wp-content/uploads/Nelson-County-Broadband-Authority-Rates-Fees-and-Charges-as-Proposed-October-14-20141.pdf, accessed October 2016

Table 14: Nelson County Broadband Authority Rates

Class of Service	Speed (Mbps)	MRC
Tier 1 Last Mile (E7 to ONT)	25x5 50x10	$25 $50
Tier 2 Last Mile or Service Provider Middle Mile (OLT to ONT/OLT)	25x25	$75
	50x50	$150
	100x100	$300
	250x250	$700
	500x500	$850
	1,000x1,000	$1,000
Tier 3 Private WAN Two Site WAN "P2P" (ONT to ONT)	25	$250
	100	$800
	500	$1,280
	1,000	$1,660
Tier 3 Private WAN Three or More Site WAN "Cloud" (per node)	100	$500
	500	$800
	1,000	$1,040

2.10 Ohio Academic Resources Network (OARnet)

The Ohio Academic Resources Network (OARnet) offers Internet bandwidth up to 10 Gbps at different price tiers. Internet pricing for 250 Mbps is a unit price of $13 per Mbps, while 1 Gbps is priced at $8 per Mbps and 3 Gbps and above is priced at $6 per Mbps as shown in Table 15.

Table 15: OARnet Internet Pricing

Bandwidth (Mbps)		Price per Mbps
Min	Max	
0	9	$20
10	39	$18
40	99	$16
100	399	$13
400	999	$10
1,000	1,749	$8
1,750	2,999	$7
3,000	Above	$6

Internet service requires the purchase of Ethernet service. Ethernet access service is available from 10 Mbps up to 40 Gbps.

- Pricing for a port speed of 250 Mbps is an MRC of $1,000 for a 24-month term and $660 for a 60-month term (not including Internet).
- For a port speed of 1 Gbps, the MRC is $1,750 for a 24-month term and $1,190 for a 60-month term. NRC for construction are additional and vary with each case (not including Internet).

2.11 Page County Broadband Authority

Page County Broadband Authority's middle mile network (in northern Virginia) is operated by Shenandoah Long Distance Telecommunications Company (SHENTEL). The pricing provided to last mile providers for transport services is listed in Table 16.[22,23]

Table 16 Page County Broadband Authority Transport Rates[24]

Bandwidth	MRC		
	5 Year	3 Year	1 Year
10 Mbps	$213	$225	$250
20 Mbps	$361	$383	$425
50 Mbps	$502	$531	$590
100 Mbps	$757	$801	$890
250 Mbps	$1,275	$1,355	$1,500
500 Mbps	$1,615	$1,710	$1,900

2.12 Roanoke Valley Broadband Authority

The Roanoke Valley Broadband Authority in Virginia provides transport and DIA service at a monthly rate shown below for a two-year term. Pricing for 10 Gbps up to 200 Gbps transport service is provided on an individual case basis.

A minimum NRC of $500 is charged for all transport and IP offerings.[25]

[22] http://www.pagecountybroadband.com/uploads/3/6/8/6/3686092/pricing_matrix_2015-03-03.pdf, accessed November 2016
[23] https://goo.gl/QTHCLk, accessed November 2016
[24] Select speeds
[25] http://highspeedroanoke.net/wp-content/uploads/2016/04/Rate-Structure-as-Adopted.pdf, accessed October 2016

Table 17: Roanoke Valley Broadband Authority – Transport Fees

Bandwidth	Unprotected (MRC)	Protected (MRC)
10 Mbps	$350	$385
20 Mbps	$450	$495
50 Mbps	$600	$660
100 Mbps	$900	$990
200 Mbps	$1,100	$1,210
300 Mbps	$1,500	$1,650
400 Mbps	$1,800	$1,980
500 Mbps	$2,200	$2,420
1 Gbps	$4,100	$4,510

Table 18: Roanoke Valley Broadband Authority – DIA Fees

Bandwidth	MRC
10 Mbps	$550
20 Mbps	$672
50 Mbps	$837
100 Mbps	$1,360
200 Mbps	$1,787
300 Mbps	$2,427
400 Mbps	$2,557
500 Mbps	$3,097
1 Gbps	$5,687

2.13 Wired Road Authority

In Carroll and Grayson counties and the city of Galax in Virginia, Wired Road Authority offers Internet service providers the use of its IP network to deliver services from 128 Kbps to 1 Gbps for a share of its revenue in direct proportion to the network capacity that they use. This revenue share model keeps the initial costs for service providers low.[26]

[26] http://thewiredroad.net/node/5, accessed October 2016

We obtained pricing from the following five commercial providers:

2.14 Cox

In Newport News, Virginia, Cox Communications offers 1 Gbps DIA service at a monthly recurring charge of $5,965 (and a $325 installation fee) and 10 Gbps DIA service at a monthly recurring charge of $18,400 (and a $625 installation fee) for a five-year term. We requested pricing on Ethernet services from Cox Communications but did not receive a response.

2.15 Zayo

Zayo's pricing for 1 Gbps and 10 Gbps point-to-point Ethernet Line services between two on-net enterprise locations, 11 miles apart, in Alexandria and Arlington County, Virginia, is as follows:

Table 19: 1 Gbps Ethernet Transport Pricing in Alexandria/Arlington

Term	12-Month	60-Month
Monthly Recurring Costs	$3,206	$2,340
Non-Recurring Costs	TBD	TBD

Table 20: 10 Gbps Ethernet Transport Pricing in Alexandria/Arlington

Term	12-Month	60-Month
Monthly Recurring Costs	$7,553	$5,513
Non-Recurring Costs	TBD	TBD

Zayo's pricing for 1 Gbps and 10 Gbps DIA in Alexandria is provided in the tables below.

Table 21: 1 Gbps DIA Pricing in Alexandria

Term	12-Month	60-Month
Monthly Recurring Costs	$5,968	$3,581
Non-Recurring Costs	TBD	TBD

Table 22: 10 Gbps DIA Pricing in Alexandria

Term	12-Month	60-Month
Monthly Recurring Costs	$28,393	$17,036
Non-Recurring Costs	TBD	TBD

2.16 Comcast

Comcast provides DIA and Ethernet services, such as Ethernet Private Line (EPL). EPL service is offered with 10 Mbps, 100 Mbps, 1 Gbps, or 10 Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1 Mbps to 10 Gbps.[27] Pricing proposed in 2014 for a 60-month term is as follows:

- 1 Gbps WAN services to 50 locations for $1,250 monthly per location.
- 3 Gbps services to 20 locations for $3,000 monthly per location.
- 5 Gbps services to 12 locations for $4,500 monthly per location.
- 10 Gbps DIA services for $14,700 monthly.

2.17 Atlantech Online

Atlantech Online offers point-to-point Ethernet and Internet services in Montgomery County, Maryland. The monthly bandwidth pricing (excluding the local loop) ranges from $8 per Mbps for 100 Mbps to $1 per Mbps for 100 Gbps. Local loop costs vary by location and competition.

2.18 Verizon

Verizon's pricing for a 1 Gbps DIA service in Montgomery County, Maryland was $6,500 per month for a three-year term in 2014.

Service to Wireless ISPs (WISPs)

ESVBA offers the EVPL WISP services to WISP customers. The rate is a combination of a monthly Ethernet Virtual Circuit (EVC) fee (of $3.50 per Mb) and monthly POP CE UNI[28] fee. The POP CE UNI MRC is $600 for 1 Gbps, $200 for 100 Mbps, and $100 for 10 Mbps. A 100 Mbps service would have a MRC of $550.

Table 13 provides networkMaryland's pricing for an EVPL service (with EVC and port monitoring). For an off-net location with 100 Mbps service, the MRC is $1,510 while an on-net location with the same speed has a MRC of $1,010. networkMaryland's EVC fee is on a decreasing scale based on data speed, starting at $15 per Mbps for 5 Mbps to $3.10 per Mbps for 500 Mbps. It matches ESVBA's pricing of $ 3.50 per Mbps only at the 400 Mbps speed.

We looked at the pricing structure of the following WISPs in the region:

- Eastern Shore Communications
- Chesapeake Bay Communications

[27] http://business.comcast.com/ethernet/products/ethernet-private-line-technical-specifications, accessed October 2016

[28] Customer Edge User Network Interface at the Service Provider's POP.

- Delmarvawifi
- Believe Wireless
- Bloosurf
- Virginia Broadband

The speeds offered by these WISPs range from 2 Mbps to 30 Mbps. We typically see an oversubscription rate of 25:1 for residential customers and 5:1 business customers. The WISP EVPL service offered by ESVBA seems to be appropriate for this market segment.

Furthermore, to assist WISP deployments:

- ESVBA has implemented "Seasonal Pricing" for Service Providers and end users to lower costs while meeting their seasonal needs.
- ESVBA has implemented the Broadband Initiative Program, which provides DIA and Transport at no charge for up to 12 months to help service providers.
- ESVBA has constructed a 100-foot monopole tower in Bloxom to assist service providers and encourage cellular providers to expand their wireless infrastructure.

The viability of the WISP business model is impacted by several factors besides the pricing of backbone service. For instance, the end user demand for WISP services is proportional to the lack of other service alternatives. A change in ESVBA backbone service pricing will not overcome weak customer demand for WISP services. The improving performance of cellular wireless data (4G LTE) across the Eastern Shore is a considerable threat to the sustainability of WISP providers.

Appendix A: Understanding Broadband Performance Factors

All megabits are *not* created equal. Speed is not the only issue in selecting the right broadband technology for your application.

Consumers usually compare the performance of data connections by evaluating network speed, which is measured in bits per second and is typically discussed in units of Mbps (approximately 1,000,000 bits per second). However, this measurement can be quite deceptive because there are other important factors in specifying broadband services.

For example, a 30 Mbps cable modem connection may cost a residential consumer $50 per month, while a business-grade Metro Ethernet service that delivers 10 Mbps Internet capacity can exceed $500 per month—yet the Internet delivered through the Metro Ethernet service provides better value for many types of applications.

Why would a service with one-third the speed cost 10 times as much as the "faster" alternative? The answer is that all Mbps are not created equal. Factors such as latency, availability of the connection speed, and the network's Internet oversubscription rate affect the connection's overall performance. In the example above, the 10 Mbps Metro Ethernet service's total set of performance attributes provides a more robust and secure connection than a 30 Mbps cable modem.

Key attributes that impact performance include:

- **Symmetry:** Cable modem and DSL services are typically asymmetrical, meaning that the upload (from user to network) and download (from network to user) speeds are different. The download speed is generally greater than the upload speed by a factor of 10. Metro Ethernet services, on the other hand, are typically symmetrical, meaning that upload and download speeds are the same. For businesses that transfer large data or video files, asymmetrical services often present bottlenecks to both internal users and external customers. A user on a typical cable modem service can download a 5 GB file in less than 10 minutes, but uploading the same file would take more than 90 minutes, which would not be acceptable to a business creating and distributing large files.

- **Oversubscription to the Internet:** Because Internet service providers (ISPs) recognize that users in a given area do not all access the Internet at the same time, ISPs subscribe to only a portion of their networks' total potential demand. For example, an ISP that has 1,000 subscribers with 10 Mbps service might contract for a 100 Mbps connection rather than the maximum 10,000 Mbps Internet connection its users might require. The ratio of a network's maximum potential demand to its contracted rates is its oversubscription ratio. In this example, the oversubscription ratio is 100:1.

Cable modem and DSL providers often have a 100:1 or greater oversubscription ratio for residential users and a 50:1 ratio for business users. If an ISP bundles Internet access with a Metro Ethernet service, the oversubscription ratio for that Internet access is often 10:1 or less. At times, users on networks with high oversubscription rates will not notice the oversubscription, while at other times oversubscription brings their connections to a crawl, just like traffic on the weekend versus traffic during a weekday rush hour.

- **Availability of the data transport rate:** Metro Ethernet providers specify a committed information rate (CIR), which is the guaranteed transport speed of the circuit connecting user locations, and the network will be designed to sustain at least that data rate for all users guaranteed that data rate. By contrast, cable modem and DSL services are often "burstable," meaning that users may experience the advertised data rates at times, but that the average speed will vary greatly based on the traffic being generated over the provider's distribution network. Performance parameters on a burstable service are rarely publicized or realized. Often a network operator cannot change this parameter without changing the network's physical connections. During periods of heavy network use, burstable subscribers experience the same traffic discrepancies, as do drivers on the road during rush hour.

  Availability is often confused with oversubscription to the Internet, but they are different. Oversubscription applies to the network's connection to the Internet, and availability applies to the "uptime" of the connection or transport between user locations or from the access point to the Internet. A service is available as long as it is operating as promised. However, as mentioned, it may still be oversubscribed, in which case it is operating but may be operating well below the peak advertised speed.

- **Maximum usage:** A network service may have a maximum data usage (in bytes) for a given period. For example, many wireless service data plans specify the number of gigabytes that users can transmit during the month. These plans carry extra fees for exceeding the limit, and the ISP may actually slow down a user's connection speed as the usage limit is neared. Cable modem and DSL providers have raised the possibility of adding usage limits to their services (for example, Comcast has trials of bandwidth limits), but implementation of such policies has so far been limited.

- **Latency:** This is the delay between the instant a message is sent and the instant it is received. Latency occurs on a provider's network; if a connection is made over the Internet, additional delays are added there. Latency is not an attribute that users can specify with cable modem and DSL services. For Metro Ethernet and other higher-end

transport services, latency is often a quality-of-service feature for which a user can contract (at an added price). At times, high latency will make it impossible for users to run certain applications. For example, satellite-based ISP services have an extremely high latency due to propagation delays (that is, the time it takes for a signal to reach the satellite). These delays prevent effective use of interactive services such as voice calls or interactive video.

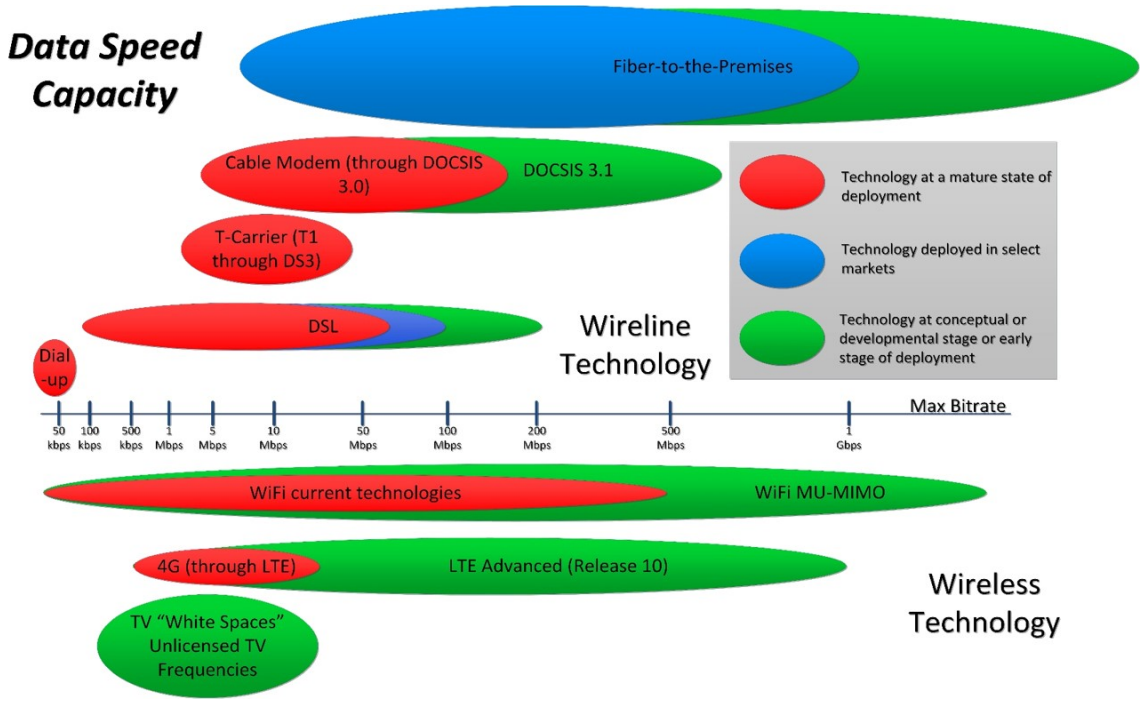
- **Connection type:** This attribute describes how a connection is made with other locations. For example, on a cable modem or DSL service, all connections to other locations are made through the Internet with Internet addressing schemes. This may require the user to set up a virtual private network (VPN) for secure communications among user locations. Establishing a VPN on the network requires cost, expertise, and software, and has an impact on performance. In contrast, higher-end data services, such as Metro Ethernet, enable a user to send traffic over the provider's network in virtual networks without connecting to the Internet, set up direct point-to-point connections, and limit, which locations may connect with one another.

- **Security:** Although security is primarily a function of encryption and other techniques applied by users or application providers, traffic over a private network is inherently more secure than traffic on a network that establishes connectivity over the Internet. A cable modem or DSL user with multiple sites transmits packets over the Internet to connect between sites. With a higher-end service such as Metro Ethernet connecting user sites, the transport would remain on the network. In addition, higher-end services often have encryption options at the transport layer.

- **Port rate:** Not all connections are equal. The network connection, drop, and customer premises equipment (CPE) define the potential connection speed at a customer site. The port rate is the maximum speed that the demarcation point to a customer can support. For cable modem services, this is defined by the network's DOCSIS version.

An example of the impact of capacity (bytes) and speed (Mbps) for selected services and network architectures is shown in Figure 1. As indicated, fiber-to-the-premises (FTTP) architecture offers far superior performance (capacity and speed) as compared with cable modem or DSL services. Indeed, with FTTP, residential and small business users can enjoy many of the enhanced attributes discussed above without the higher price often associated with Metro Ethernet.

Figure 6: Capacity and Speed of Broadband Technologies



Appendix B: Westminster, Maryland Case Study

The City of Westminster, Maryland, is a bedroom community of both Baltimore and Washington D.C. where 60 percent of the working population leaves in the morning to work elsewhere.[29] The area has no major highways and thus, from an economic development perspective, has limited options for creating new jobs. Incumbents have also traditionally underserved the area with broadband.

The City began an initiative 12 years ago to bring better fiber connectivity to community anchor institutions through a middle mile fiber network. In 2010, the State of Maryland received a large award from the federal government to deploy a regional fiber network called the Inter-County Broadband Network (ICBN) that included infrastructure in Westminster.[30]

Westminster saw an opportunity to expand the last mile of the network to serve residents. At the time, however, it did not have any clear paths to accomplish this goal. Town leaders looked at other communities and quickly realized that they were going to have to do something unique. Unlike FTTP success stories such as Chattanooga, Tennessee, they did not have a municipal electric utility to tackle the challenge. They also did not have the resources, expertise, or political will to develop from scratch a municipal fiber service provider to compete with the incumbents. As a result, they needed to find a hybrid model.

As the community evaluated its options, it became clear that the fiber infrastructure itself was the City's most significant asset. All local governments spend money on durable assets with long lifespans, such as roads, water and sewer lines, and other infrastructure that is used for the public good. The leaders asked, "Why not think of fiber in the same way?" The challenge then was to determine what part of the network implementation and operations the private sector partner would handle and what part could be the City's responsibility.

The business model that made the most sense required the City to build, own, and maintain dark fiber, and to look to partners that would light the fiber, deliver service, and handle the customer relationships with residents and businesses. The model would keep the City out of network operations, where a considerable amount of the risk lies in terms of managing technological and customer service aspects of the network.

[29] Case study is based in part on a presentation by Dr. Robert Wack, President, Westminster (Maryland) Town Council, during a webinar hosted by the Fiber to the Home Council and facilitated by CTC Technology & Energy. *See*: http://goo.gl/x82Ro7 (password required). See also: Robert Wack, "The Westminster P3 Model," *Broadband Communities Magazine* (Nov./Dec. 2015), http://goo.gl/op1XpH

[30] "The Project," Inter-County Broadband Network, http://goo.gl/GjBC26

The City solicited responses from potential private partners through a request for proposals (RFP). Its goal was to determine which potential partners were both interested in the project and shared the City's vision.

The City eventually selected Ting Internet, an upstart ISP with a strong track record of customer service as a mobile operator. Ting shared Westminster's vision of a true public–private partnership and of maintaining an open access network. Ting has committed that within two years it will open its operations up to competitors and make available wholesale services that other ISPs can then resell to consumers.

Under the terms of the partnership, the City is building and financing all of the fiber (including drops to customers' premises) through a bond offering. Ting is leasing fiber with a two-tiered lease payment. One monthly fee is based on the number of premises the fiber passes; the second fee is based on the number of subscribers Ting enrolls.

Based on very preliminary information, given that this is a market in development as we write, we believe this is a highly replicable model.

What is so innovative about the Westminster model is how the risk profile is shared between the City and Ting. The City will bond and take on the risk around the outside plant infrastructure, but the payment mechanism negotiated is such that Ting is truly invested in the network's success.

Because Ting will pay Westminster a small monthly fee for every home and business passed, Ting is financially obligated to the City from day one, even if it has no customers. This structure gives the City confidence that Ting will not be a passive partner, because Ting is highly incented to sell services to cover its costs.

Ting will also pay the City based on how many customers it serves. Initially, this payment will be a flat fee—but in later years, when Ting's revenue hits certain thresholds, Ting will pay the City a small fraction of its revenue per user. That mechanism is designed to allow the City to share in some of the upside of the network's success. In other words, the City will receive a bit of entrepreneurial reward based on the entrepreneurial risk the City is taking.

Perhaps most significantly, there is also a mechanism built into the contract that ensures that the two parties are truly sharing risk around the financing of the outside plant infrastructure. In any quarter in which Ting's financial obligations to the City are insufficient to meet the City's debt service, Ting will pay the City 50 percent of the shortfall. In subsequent quarters, if Ting's fees to the Town exceed the debt service requirements, Ting will be reimbursed an equivalent

amount. This element of the financial relationship made the deal much more attractive to the City because it is a clear demonstration of the fact that its private partner is invested with it.

Appendix C: Garrett County, Maryland Case Study

The Westminster case study presented in Appendix A is promising, but a similar project may be more challenging to replicate in rural communities, where the cost of fiber deployment, even in a shared-investment scenario, may still be prohibitive.

A shared investment and shared risk strategy as presented in Appendix A, however, is still applicable to rural communities—perhaps using other technologies that secure the benefits of broadband even if they do not result in the kinds of speeds that fiber enables.

Garrett County, in far western Maryland, is a relatively remote Appalachian community bordered by West Virginia and Pennsylvania. The county has struggled to get broadband in a number of its remote, mountainous areas. Where broadband is available, it is inadequate DSL service that does not meet the Federal Communications Commission's (FCC) new speed benchmark for broadband service, let alone the requirements for home-based businesses or home schooling. The incumbent provider has not made any plans to expand or upgrade service offerings.

Though mobile broadband is available in some parts of the county, data caps mean that it is not viable for economic or educational activities. For example, parents who homeschool their children can run through their monthly bandwidth allotment in one day of downloading educational videos. Beyond these challenges for residents, the county has struggled to attract and retain businesses and teleworkers.

In response, the county has gradually and incrementally built out fiber in some areas, with a focus on connecting specific institutions. In September 2015, the County Council approved a contract with a private partner to leverage some of that fiber and additional public funding to support the deployment of a fixed-wireless broadband network that will serve up to 3,000 currently unserved homes in the most remote parts of the county. The private partner, Declaration Networks Group (DNG), will also put its own capital toward the construction of the network, and will apply its technical and operational capabilities to managing the network.

The partnership involves cost to the county, but also massive benefit for residents and businesses in the newly served areas.

The county's outlay of funds will be $750,000, which will be matched by a grant from the Appalachian Regional Commission (ARC) and which will be more than matched by DNG's commitment of both capital and operating funds. That relatively modest county contribution, which was then leveraged for the ARC economic development funding, made the economics of this opportunity very attractive to DNG, and secured a broadband buildout for an area that would otherwise not be attractive for private sector broadband investment.

From an economic development perspective, the county's investment represents enormous value for the dollar. This investment will enable residents in 3,000 homes to buy cost-effective broadband service that they cannot access now, and that will make possible telework, home-based businesses, and home schooling. This investment will also enable the county to close the homework gap for many students in the county schools who do not currently have broadband in their homes—an increasingly critical lack of service.

As the network is deployed over the next few years, the county will reduce to nearly zero the number of homes in the county that do not have access to some kind of broadband communications options. These options may be modest—not the robust speeds available in metro markets—but they are significantly better than nothing, and a huge economic development achievement from the county's standpoint.