

ctc technology & energy

engineering & business consulting



Appendix B: Assessment of Local Broadband Market

Prepared for the City of Hayward, California

October 2016

Columbia Telecommunications Corporation

10613 Concord Street • Kensington, MD 20895 • Tel: 301-933-1488 • Fax: 301-933-3340 • www.ctcnet.us

Contents

1	Enterprise Market.....	1
1.1	Dark Fiber Services.....	1
1.2	Lit Services	3
2	Residential and Small Business Services.....	12
2.1	Cable	12
2.2	DSL	13
2.3	Fiber	14
2.4	Fixed Wireless	14
2.5	Satellite	17

Figures

Figure 1:	Integra Fiber Paths	1
Figure 2:	Level 3 Fiber Routes	2
Figure 3:	Zayo Fiber Routes	3
Figure 4:	Comcast Fiber Routes	5
Figure 5:	EarthLink Fiber Map	6
Figure 6:	TelePacific Fiber Routes.....	8
Figure 7:	Windstream Fiber Routes.....	9
Figure 8:	XO Fiber Routes	10
Figure 9:	Etheric Fixed Wireless Coverage Area	16

Tables

Table 1:	Zayo Ethernet Transport Pricing in Hayward (Monthly Recurring Cost).....	11
Table 2:	Zayo DIA pricing in Hayward (Monthly Recurring Cost).....	11
Table 3:	Overview of Residential and Small Business Data Services in Hayward	12
Table 4:	Comcast Residential Internet—Internet Only.....	13
Table 5:	Comcast Small Business Internet—Internet Only.....	13
Table 6:	AT&T Residential Internet—Internet Only	13
Table 7:	Etheric Residential Plans.....	15
Table 8:	Etheric SO/HO Plans	15
Table 9:	Etheric Business Plans.....	15

Table 10: HughesNet Satellite Residential Plans17
Table 11: HughesNet Satellite Business Plans17

1 Enterprise Market

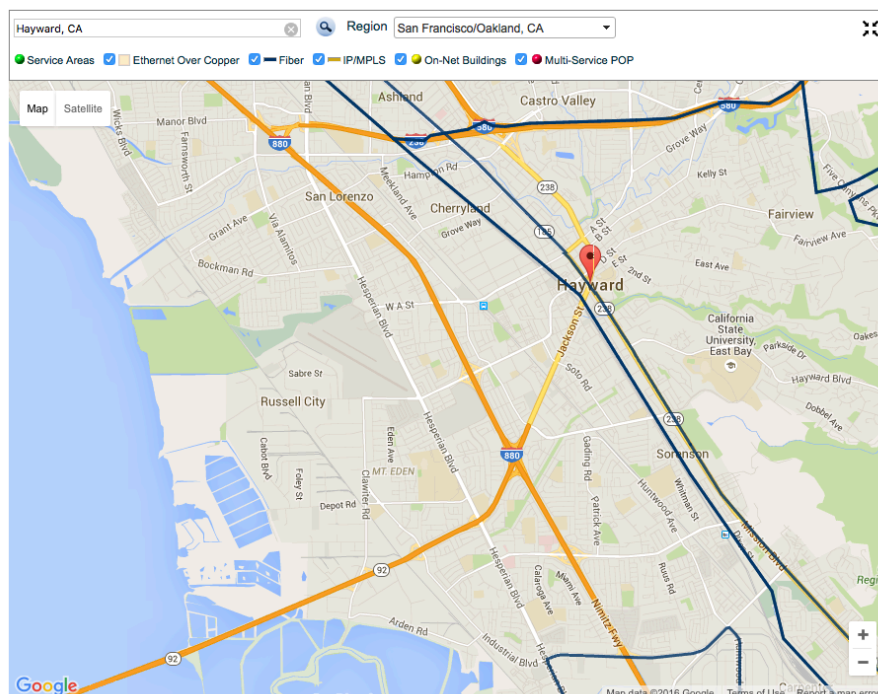
This section provides an overview of competitive providers for dark fiber and lit services with respect to the residential and small business customers within the City of Hayward. During our research, we identified 14 service providers in the Hayward area that offer a range of services, from dark fiber connectivity to data transport services, with speeds that range from 1 Mbps to 100 Gbps. Individual providers tailor these services to customers' requirements (e.g., speed, class of service). Greater proximity to the provider's existing network infrastructure results in lower service pricing. Providers typically prefer to offer transport services between locations on their networks (on-net) and provision Multiprotocol Label Switching (MPLS) based services for connecting locations that are off-net.

1.1 Dark Fiber Services

Four service providers in the City have dark fiber availability: Integra Telecom, Level 3, Line Systems, and Zayo.

Integra Telecom, which operates primarily in the western U.S., has long-haul and metro fiber in Hayward (Figure 1). Integra offers lease and Indefeasible Rights of Use (IRU) options.¹

Figure 1: Integra Fiber Paths²

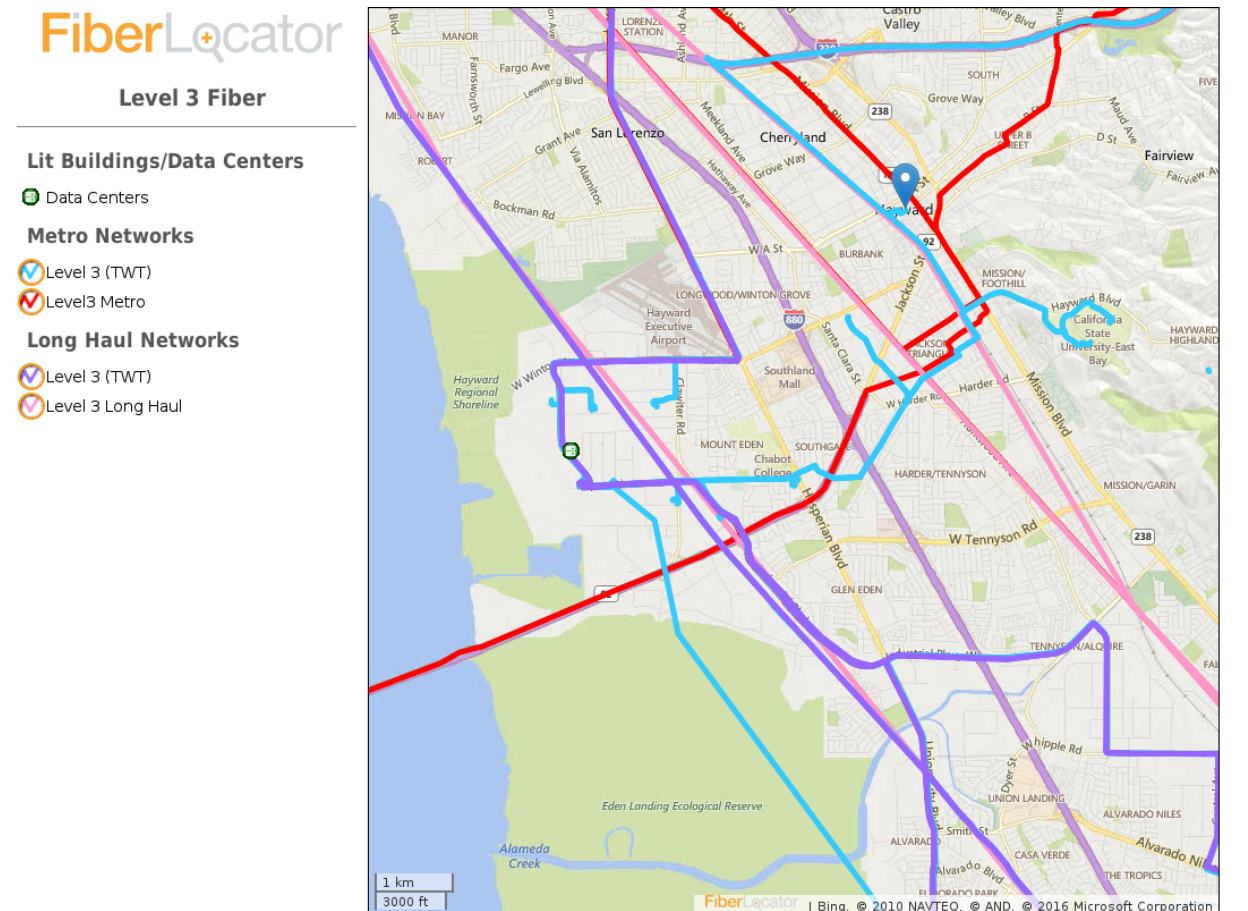


¹ <http://www.integratecom.com/enterprise/products/pages/dark-fiber-network-provider.aspx>, accessed June 2016.

² <http://www.integratecom.com/pages/network-map.aspx> accessed June 2016.

Level 3 has long-haul dark fiber routes and metro fiber in Hayward, as depicted in Figure 2. Pricing varies based on the customer’s distance from Level 3’s infrastructure. A difference of a few tenths of a mile can lead to significant differences in the price of dark fiber connectivity, due to additional construction costs.

Figure 2: Level 3 Fiber Routes³



Line Systems operates within the United States as well as in Canada, England, and Singapore. The company offers dark or lit private fiber services with a range of options for leasing or independent ownership. Pricing varies significantly by location, depending on construction costs.⁴

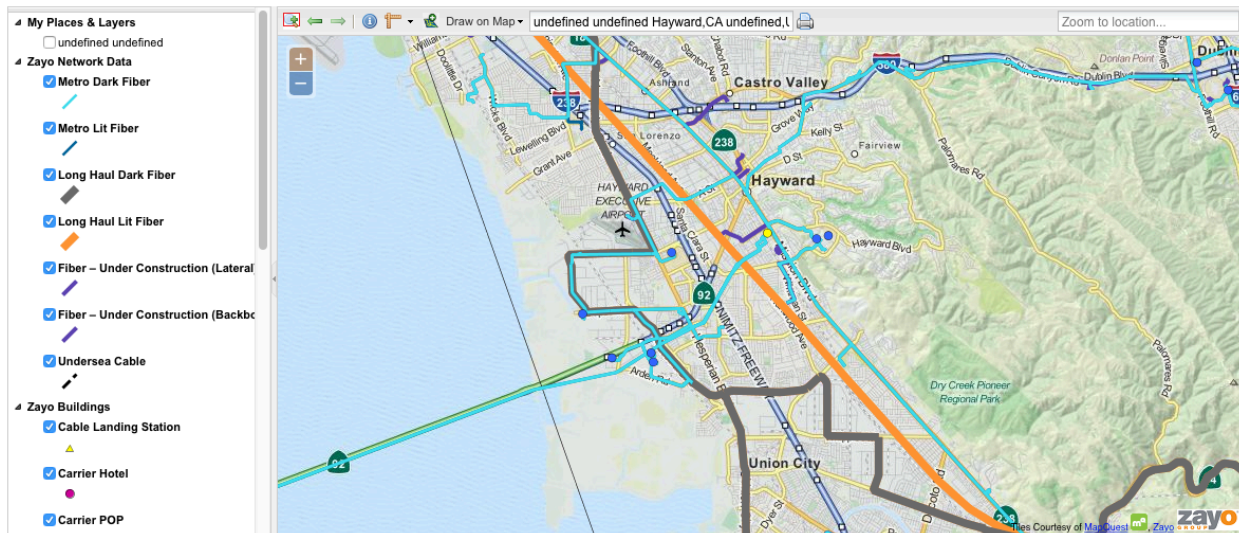
Zayo provides dark fiber connectivity over its network of metro and intercity fiber, as depicted in Figure 4. The company claims to have proven expertise in deploying major new dark fiber networks and offers multiple financing options, including leases and IRU agreements. Pricing

³ <http://fiberlocator.com>, accessed June 2016.

⁴ <http://linesystems.com/services/data/ethernet-services>, accessed June 2016.

varies significantly depending on whether the customer site is on-net or not; if the location is off-net, construction and splicing costs would apply. As an example, a dark fiber lease between two on-net locations, (one in San Francisco, one in Hayward) that are 25 miles apart has a monthly recurring charge of \$11,166 for a one-year term and \$5,592 for a five-year term. The customer will also pay additional non-recurring charges, which we have typically seen to be approximately \$5,000.⁵

Figure 3: Zayo Fiber Routes⁶



1.2 Lit Services

Ethernet service can be classified into three types—Ethernet Private Line (EPL or E-Line), Ethernet Virtual Private Line (EVPL), and ELAN:

- EPL is a dedicated, point-to-point, high-bandwidth Layer 2 private line between two customer locations.
- EVPL service is similar to EPL but is not dedicated between two locations. Instead, it provides the ability to multiplex multiple services from different customer locations onto one point on the provider’s network (multiple virtual connections) to another point on the network.
- ELAN is a multipoint-to-multipoint connectivity service that enables customers to connect physically distributed locations across a Metropolitan Area Network (MAN) as if they were on the same Local Area Network (LAN).

⁵ <http://www.zayo.com/services/dark-fiber>, accessed June 2016.

⁶ <http://www.zayo.com/solutions/global-network/>, accessed June 2016.

Internet services over Ethernet are typically classified under two categories: Dedicated Internet Access (DIA) and MPLS IP Virtual Private Networks (IP-VPN). Providers prefer to offer MPLS-based IP-VPN services when the service locations are off-net, thus avoiding construction and installation costs. MPLS-based networks provide high performance for real-time applications such as voice and video and are typically priced higher.

The carriers that provide these services in the Hayward area are Access One, AT&T, Comcast, EarthLink, Integra, Level 3, Line Systems, MegaPath, Sonic, TelePacific, Windstream, XO Communications, and Zayo. Prices depend on the bandwidth, location, and network configuration; whether the service is protected or unprotected; and whether the service has a switched or mesh structure.

Access One provides a range of business-focused solutions over fiber with speeds ranging from 1.5 Mbps to 1 Gbps.⁷ Services include DIA, MPLS IP-VPN, and EPL. Access One operates in 30 states, but has the highest coverage in California, Illinois, and New Jersey.⁸

AT&T has three basic types of Ethernet products—Dedicated Ethernet, Switched Ethernet, and OPT-E-WAN—which are similar to EPL and ELAN.⁹ Dedicated Ethernet services provide point-to-point Ethernet connectivity between two customer locations, while Switched Ethernet and OPT-E-WAN can facilitate point-to-point, point-to-multipoint, or multipoint-to-multipoint service. All support bandwidths ranging from 1 Mbps to 1 Gbps. Connections and speed can be managed directly by the customer and new locations can be added quickly in multipoint scenarios.

Comcast provides EPL services, which enable customers to connect their customer premises equipment (CPE) using a lower-cost Ethernet interface, as well as using any Virtual Local Area Networks (VLAN) or Ethernet control protocol across the service without coordination with Comcast.

Comcast offers EPL service 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.¹⁰ Comcast's fiber optic network is depicted in Figure 3.

⁷ <http://www.accessoneinc.com/services/data-services.aspx>, accessed June 2016.

⁸ <http://broadbandnow.com/Access-One>, accessed June 2016.

⁹ <https://www.business.att.com/enterprise/Family/network-services/ethernet/>, accessed June 2016.

¹⁰ <http://business.comcast.com/ethernet/products/ethernet-private-line-technical-specifications>, accessed June 2016.

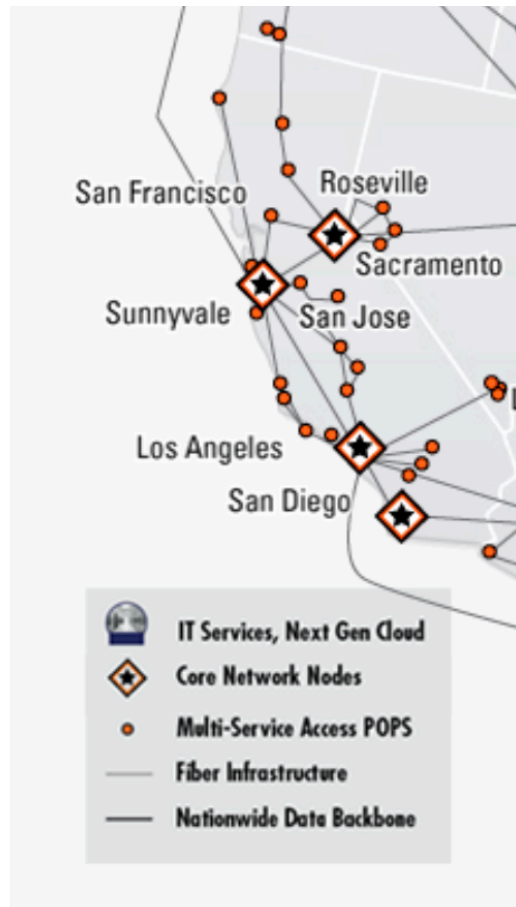
Figure 4: Comcast Fiber Routes¹¹



EarthLink offers a variety of Ethernet services in Hayward, including DIA, MPLS IP-VPN, and IPsec VPN, which uses the IPsec protocol instead of IP over MPLS. It also offers Hybrid WAN service, which allows connectivity between multiple locations with different types of service. Symmetrical Ethernet service is available over both copper and fiber connections. The cost of a typical 100 Mbps fiber service would be in the range of \$1,900 per month, but pricing varies significantly by location, proximity to existing infrastructure, and construction costs.

¹¹ <http://business.comcast.com/about-us/our-network>, accessed June 2016.

Figure 5: EarthLink Fiber Map¹²



Integra offers several Ethernet services, including DIA, E-Line, E-LAN, and MPLS IP-VPN. Available speeds range from 1.5 Mbps to 10 Gbps. It also offers wavelengths over fiber using Dense Wave Division Multiplexing (DWDM). DWDM allows several different point-to-point connections to be carried over the same strand of fiber using different wavelengths of light, greatly expanding the amount of bandwidth available over a single strand. This is often used in long-haul applications (where the expense of a DWDM system is justified by the avoided expense of constructing additional fiber over long distances), but it also has regional applications.

Level 3's Metro Ethernet dedicated service is available in bandwidth options of 3 Mbps to 1 Gbps and its EVPL offers speeds ranging from 3 Mbps to 10 Gbps.¹³ It is an end-to-end, Layer 2, switched Ethernet service delivered via an MPLS backbone. Internet services are available in a range of 14 speeds up to 10 Gbps.¹⁴

¹² <https://www.earthlink.com/why-earthlink/our-network>, accessed June 2016.

¹³ <http://www.level3.com/en/products/virtual-private-lan-service>, accessed June 2016.

¹⁴ http://www.level3.com/~media/files/factsheets/en_ethernet_fs_ethernetmatrix.pdf, accessed June 2016.

Line Systems offers a lit private fiber service with terms similar to its dark fiber offering, and a point-to-point Ethernet service with speeds of 10, 50, or 100 Mbps. It also offers a metro-area LAN service called Fastpath. Fastpath is available at several speeds ranging from 1 Mbps to 1 Gbps and offers Quality of Service (QoS) management via separate Ethernet Virtual Connections (EVCs) or VLANs.

Line Systems provided a rough cost estimate of \$1,200 to \$1,400 per month for 100 Mbps Fastpath service and approximate \$4000 per month for 1 Gbps service, but price and availability may vary significantly by location. Line Systems also offers an MPLS IP-VPN service.¹⁵

MegaPath offers a fiber DIA service called Fiber Access which provides symmetrical connectivity at speeds ranging from 5 Mbps to 1 Gbps.¹⁶ Our staff corresponded with MegaPath sales staff to obtain pricing information. A 1 Gbps fiber connection costs approximately \$8,000 per month. MegaPath also offer MPLS and IPsec VPN services for connecting multiple locations. MegaPath also offers symmetric and asymmetrical Ethernet service.¹⁷

MegaPath's asymmetrical service starts at \$90 per month for 8 Mbps download speeds and 1 Mbps upload, and ranges up to \$243 per month for 50 Mbps down and 10 Mbps up. Symmetrical Ethernet ranges from \$299 per month for 2 Mbps service to \$1,399 for 45 Mbps service. Signing a three-year contract will provide the best pricing and enable customers to waive the initial installation fee.

TelePacific offers a range of business connectivity options, including fiber connections up to 10 Gbps where fiber is available (Figure 6). It offers an EPL service called Metro Private Line for point-to-point connections between two locations, as well as IPsec and MPLS IP-VPN services.

TelePacific does not have its own fiber in the City, but offers its services over fiber leased from other providers.¹⁸

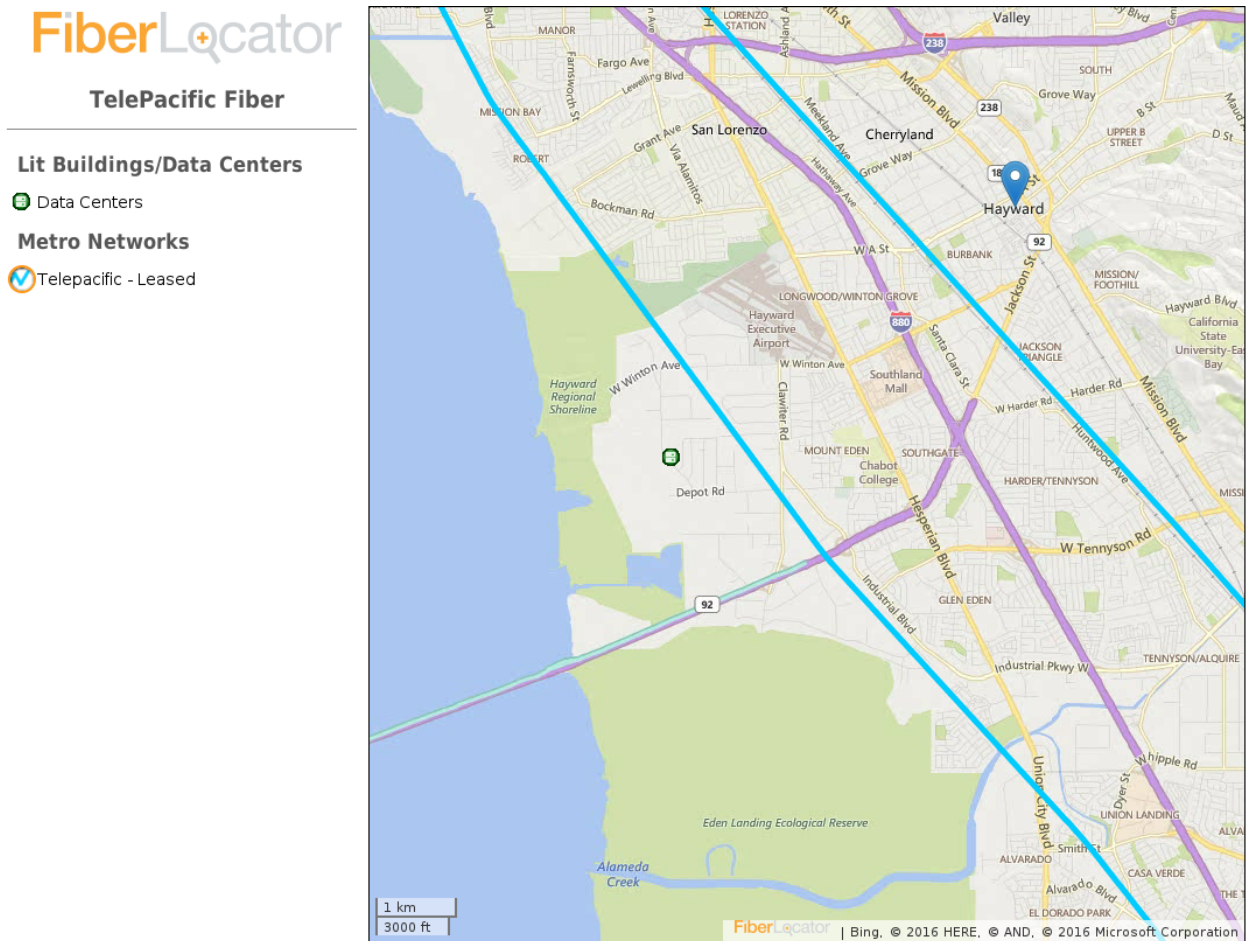
¹⁵ <http://linesystems.com/services/data/ethernet-services>, accessed June 2016.

¹⁶ <https://www.megapath.com/data/fiber-access>, accessed June 2016.

¹⁷ <https://www.megapath.com/data/ethernet>, accessed June 2016.

¹⁸ <http://www.telepacific.com/offer/data-networking/internet-access/ethernet-broadband.asp>, accessed June 2016.

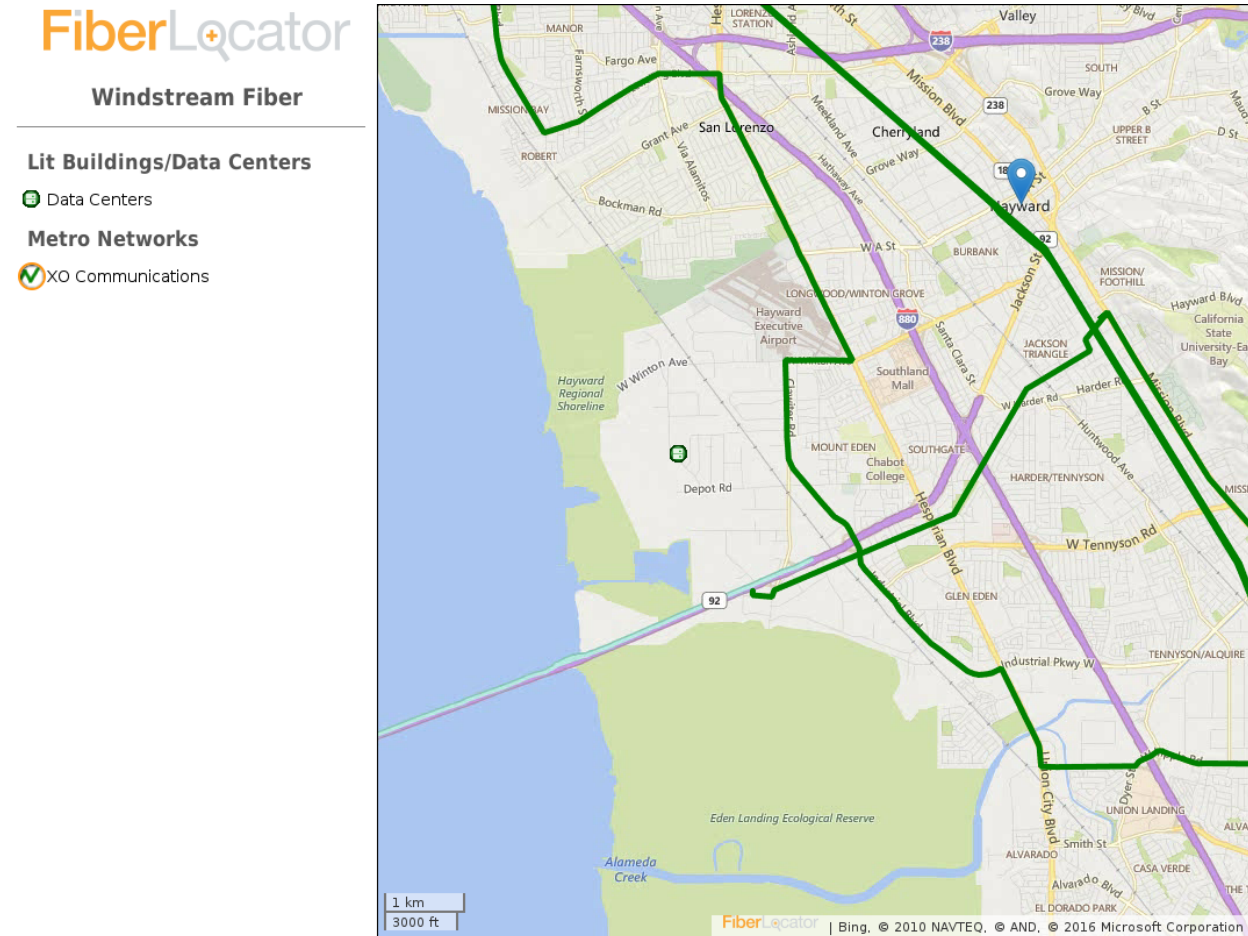
Figure 6: TelePacific Fiber Routes¹⁹



¹⁹ <https://fiberlocator.com>, accessed June 2016.

Windstream Communications has a nationwide presence serving major metropolitan areas. In Hayward, it offers DIA services with speeds up to 1 Gbps.²⁰ It also provides MPLS IP-VPN and an E-LAN product called VLS (Virtual LAN Service).²¹ Windstream also sells wavelengths over regional, metro, and long-haul fiber. Available speeds are 1 Gbps, 2.5 Gbps, 10 Gbps, 40 Gbps, and 100 Gbps.²²

Figure 7: Windstream Fiber Routes²³



²⁰ <http://www.windstreambusiness.com/products/enterprise-network-services/dedicated-internet-services/ethernet-internet>, accessed June 2016.

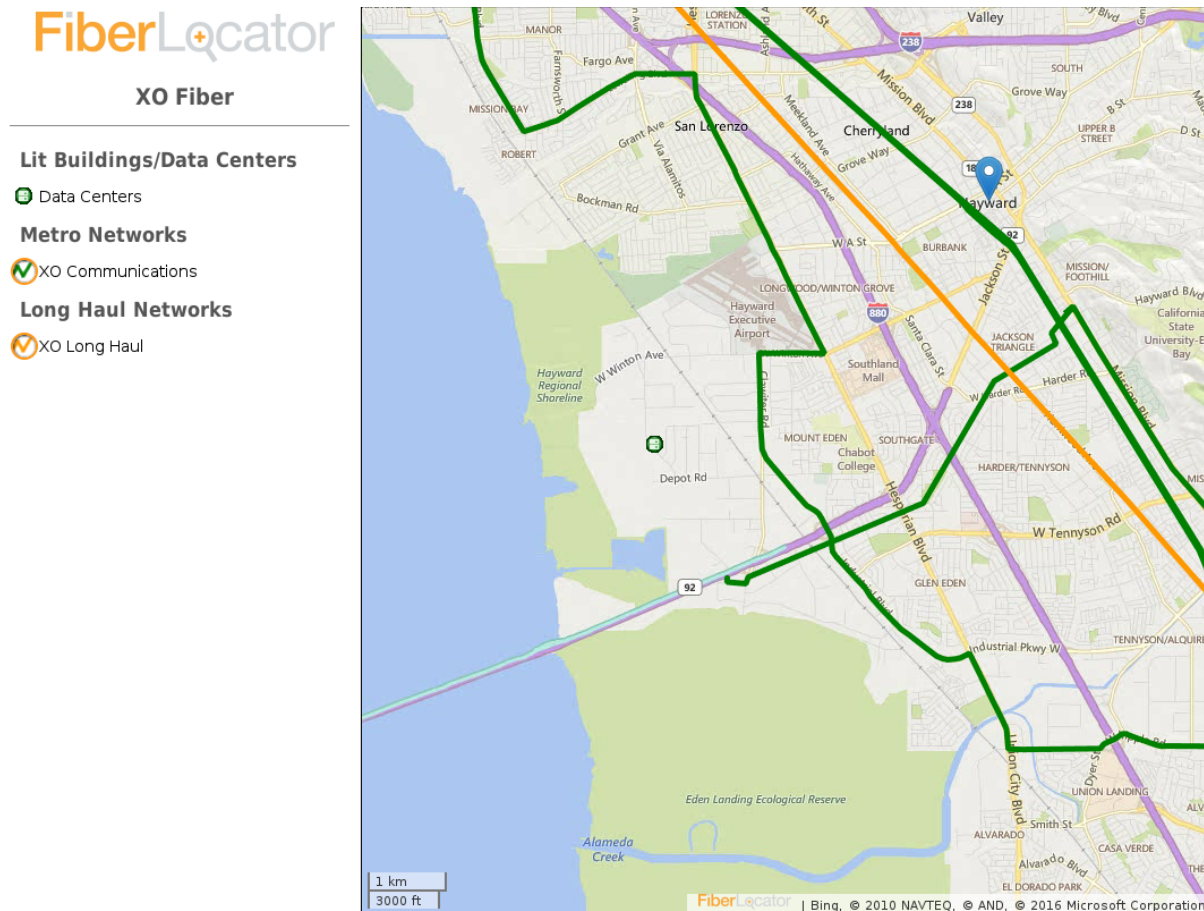
²¹ <http://www.windstreambusiness.com/shop/products/ca/Hayward>, accessed June 2016.

²² <http://www.windstreambusiness.com/products/enterprise-network-services/dedicated-internet-services/wave-service> accessed June 2016.

²³ <https://fiberlocator.com>, accessed June 2016.

XO Communications offers carrier Ethernet and DIA services at multiple bandwidth options, from 3 Mbps to 10 Gbps, over its Tier 1 IP network. XO does not have fiber in the City but resells services over routes provided by other providers.^{24, 25}

Figure 8: XO Fiber Routes²⁶



Zayo delivers Ethernet in three service types, with bandwidth ranging from 10 Mbps to 100 Gbps and options like quality of service (QoS) guarantees and route protection based on customer needs. The different types of services offered are: Ethernet-Line, which provides point-to-point and point-to-multipoint configurations with reserved bandwidth availability; Ethernet-LAN, with multipoint configurations having a guaranteed service level; and Ethernet

²⁴ <http://www.xo.com/carrier/transport/ethernet/>, accessed May 2016.

²⁵ <http://www.xo.com/network-services/internet-access/ip-transit/100G/>, accessed May 2016.

²⁶ <https://fiberlocator.com>, accessed June 2016.

Private Dedicated Network (E-PDN) with a completely private, managed network operated by Zayo, with dedicated fiber and equipment.²⁷

Zayo’s FlexConnect service allows customers to pay for bandwidth used at \$0.03 per gigabyte with no minimums, plus a monthly port charge ranging from \$50 for 500 Mbps to \$250 for 10 Gbps.²⁸

Pricing for a 10 Gbps and 1 Gbps point-to-point Ethernet line between two on-net locations in Hayward that are a mile apart is provided in the tables below. We would see non-recurring charges depending on the proximity of a site to the existing Zayo network.

Table 1: Zayo Ethernet Transport Pricing in Hayward (Monthly Recurring Cost)

Service	60 Month	12 Month
1 Gbps	\$1,841	\$2,522
10 Gbps	\$4,337	\$5,941

Pricing for a 10 Gbps and 1 Gbps DIA service at an on-net location in Hayward is provided in the table below.

Table 2: Zayo DIA pricing in Hayward (Monthly Recurring Cost)

Service	60 Month	12 Month
1 Gbps	\$4,016	\$6,693
10 Gbps	\$19,103	\$31,843

²⁷ <http://www.zayo.com/ethernet>, accessed May 2016.

²⁸ <http://www.zayo.com/services/ethernet/flexconnect>, accessed June 2016.

2 Residential and Small Business Services

Residential and small business customers in the Hayward area have access to a range of services, though individual service options are dependent on location. Table 3 lists the service providers and minimum price for each type of service that is available in at least some part of the City.

Table 3: Overview of Residential and Small Business Data Services in Hayward

Service Type	Provider	Minimum Monthly Price
Cable	Comcast	\$29.99
DSL	AT&T	\$25
	Sonic	\$40
	EarthLink	\$14.95
Fiber	Comcast	\$299.95
Fixed Wireless	Etheric	\$99
Satellite	HughesNet	\$59.99
	Exede	\$59.99

2.1 Cable

Comcast offers Internet service with download speeds from 25 Mbps to 250 Mbps starting at \$29.99 per month in some locations in the City. Promotional rates are available for the first year, after which the rates increase. Discounted prices are available if bundled with another service like voice or TV.²⁹ On the small business side, multiple options are available starting at 16 Mbps download speeds up to 150 Mbps download speeds, as illustrated in Table 3.³⁰ Bundling with voice introduces a monthly savings of \$30 to \$40. Comcast also offers residential fiber service, which is discussed below.

²⁹ <http://www.comcast.com/internet-service.html>, accessed June 2016.

³⁰ <http://business.comcast.com/internet/business-internet/plans-pricing>, accessed June 2016.

Table 4: Comcast Residential Internet—Internet Only

Package	Internet Speed	Monthly Regular Price	Monthly Promo Rate
Performance Starter	Up to 10 Mbps download	\$29.99	\$49.95
Performance 25	Up to 25 Mbps download	\$39.99	\$59.95
Performance Pro	Up to 100 Mbps download	\$49.99	\$74.95
Blast Pro	Up to 200 Mbps download	\$59.99	\$89.95
Extreme 250	Up to 250 Mbps download	\$79.99	\$149.95

Table 5: Comcast Small Business Internet—Internet Only

Package	Internet Speed	Monthly Price
Starter	16 Mbps download/3 Mbps upload	\$69.95
Deluxe 25	25 Mbps download/10 Mbps upload	\$99.95
Deluxe 50	50 Mbps download/ 10 Mbps upload	\$109.95
Deluxe 75	75 Mbps download/15 Mbps upload	\$149.95
Deluxe 100	100 Mbps download/20 Mbps upload	\$199.95
Deluxe 150	150 Mbps download/20 Mbps upload	\$249.95

2.2 DSL

AT&T offers DSL service for residential customers in Hayward, starting at as \$30 per month for unbundled or standalone DSL service at 6 Mbps download with a 12-month commitment. Additional options up to 75 Mbps are available, as indicated in Table 6.

Table 6: AT&T Residential Internet—Internet Only

Internet Speed	Monthly Price	Monthly Promo Rate
----------------	---------------	--------------------

Internet Speed	Monthly Price	Monthly Promo Rate
Up to 6 Mbps download	\$40	\$30
Up to 24 Mbps download	\$60	\$50
Up to 45 Mbps download	\$70	\$60
Up to 75 Mbps download	\$80	\$70

AT&T offers DSL-based small business services starting at \$70 per month for 12 Mbps download and 1.5 Mbps upload speeds.³¹

EarthLink provides DSL-based business services in the region starting at \$80 per month and offering speeds up to 6 Mbps with 99.9 percent network availability.³²

Sonic provides DSL-based services called Fusion starting at \$40 for 10 Mbps or 20 Mbps download, depending on the location. Where available, Fusion X2 provides double the speed of Fusion for \$60. Business DSL and phone bundles also start at \$40 per month.³³ Sonic is in the process of deploying fiber in the Bay Area, but has not announced availability in Hayward.

2.3 Fiber

Comcast, in addition to Internet connectivity over coaxial cable, offers its Gigabit Pro fiber service in Hayward. The service provides 2 Gbps speeds for \$299.95 per month and requires a two-year contract plus \$1,000 in up-front installation and activation fees. Gigabit Pro is available for residential customers only.³⁴

2.4 Fixed Wireless

Fixed wireless services use long-range wireless signals between the provider's antenna and an antenna installed in a fixed location at the customer's home or business.

Etheric Networks provides wireless service to much of the Bay Area. Plan pricing varies by guaranteed and maximum speed and monthly data caps, and are broken out into three classes of service: residential, small office/home office (SOHO), and business. Because wireless service can be affected by topology and obstructions such as trees or buildings, Etheric offers a free

³¹ <https://www.att.com/internet>, accessed June 2016.

³² <http://www.earthlinkbusiness.com/DSL>, accessed June 2016.

³³ <https://www.sonic.com/availability>, accessed June 2016.

³⁴ <http://www.xfinity.com>, accessed June 2016.

site survey to determine availability of service. Plan pricing and details are broken out in the tables below.

Table 7: Etheric Residential Plans³⁵

Plan	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Silver NG	\$99	3 Mbps	15 Mbps	300 GB
Gold NG	\$139	6 Mbps	30 Mbps	500 GB
Platinum NG	\$179	10 Mbps	38 Mbps	1,000 GB
Diamond NG	\$229	15 Mbps	45 Mbps	1,500 GB
Burst 100 NG*	\$349	25 Mbps	100 Mbps	2,400 GB

Table 8: Etheric SO/HO Plans³⁶

Plan	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Silver NG	\$159	3 Mbps	9 Mbps	500 GB
Gold NG	\$229	6 Mbps	15 Mbps	900 GB
Platinum NG	\$339	10 Mbps	25 Mbps	1,950 GB
Diamond NG	\$449	15 Mbps	35 Mbps	3,000 GB
Adamantium NG	\$599	20 Mbps	50 Mbps	4,000 GB
Burst 100 NG*	\$699	25 Mbps	100 Mbps	5,000 GB

Table 9: Etheric Business Plans³⁷

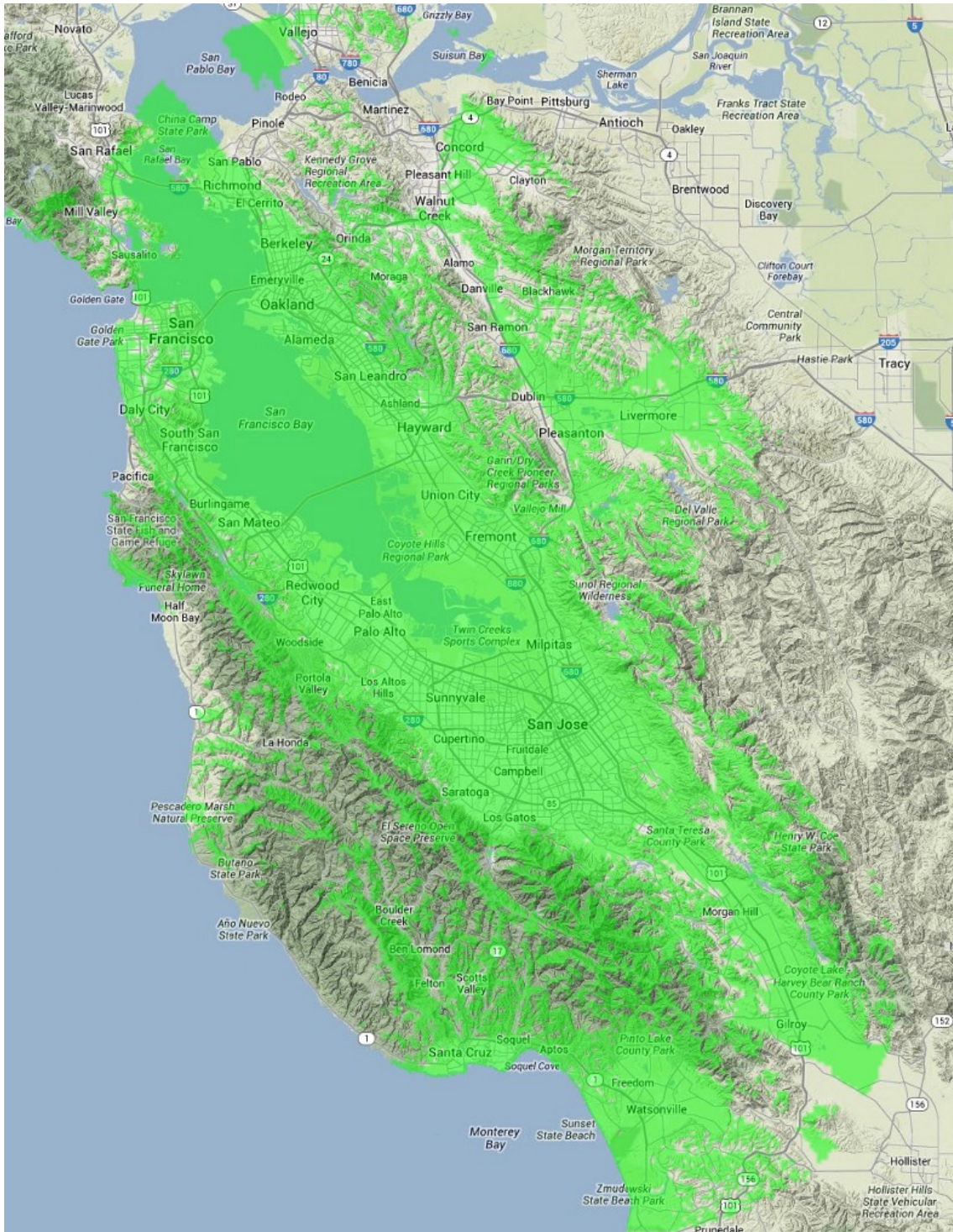
Next Gen (G6) Plan Details	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Bronze NG	\$199	2 Mbps	5 Mbps	Unlimited
Silver NG	\$249	3 Mbps	9 Mbps	Unlimited
Gold NG	\$399	6 Mbps	15 Mbps	Unlimited
Platinum NG	\$499	10 Mbps	25 Mbps	Unlimited
Economy ENX	\$699	20 Mbps	50 Mbps	Unlimited
Standard ENX	\$999	30 Mbps	75 Mbps	Unlimited
Comprehensive ENX	\$1,299	50 Mbps	100 Mbps	Unlimited
Maximum ENX	\$1,499	100 Mbps	150 Mbps	Unlimited

³⁵ <http://ethericnetworks.com/residential>, accessed June 2016.

³⁶ <http://ethericnetworks.com/soho-small-office>, accessed June 2016

³⁷ <http://ethericnetworks.com/business-class>, accessed Just 2016

Figure 9: Ethernic Fixed Wireless Coverage Area³⁸



³⁸ <http://ethernicnetworks.com/coverage-map>, accessed June 2016.

2.5 Satellite

Satellite Internet access is available in the area as well. **HughesNet** has four residential packages available and four geared toward businesses. In addition to slight increases in download and upload speeds, plans are differentiated by their monthly data allowances. Residential offerings include an anytime allowance, plus a larger 50 GB “bonus bytes” allowance which can be used from 1 a.m. to 10 a.m. Business offerings include a “business period” allowance to be used between 8 a.m. and 6 p.m. plus a smaller 10 GB anytime allowance. All packages require a two-year agreement. Details and pricing are listed in the tables below.

Table 10: HughesNet Satellite Residential Plans³⁹

Package	Internet Speed	Monthly Data Allowance (Anytime + Bonus Bytes)	Monthly Price
Choice	5 Mbps down/1 Mbps up	5 GB + 50 GB	\$49.99
Prime Plus	10 Mbps down/1 Mbps up	10 GB + 50 GB	\$59.99
Pro Plus	10 Mbps down/ 2 Mbps up	15 GB + 50 GB	\$79.99
Max	15 Mbps down/2 Mbps up	20 GB + 50 GB	\$129.99

Table 11: HughesNet Satellite Business Plans⁴⁰

Business Package	Internet Speed	Monthly Data Allowance (Business Period + Anytime)	Monthly Price
Select 100	10 Mbps down/1 Mbps up	20 GB + 10 GB	\$79.99
Select 200	10 Mbps down/ 2 Mbps up	30 GB + 10 GB	\$99.99
Select 300	10 Mbps down/ 2 Mbps up	40 GB + 10 GB	\$129.99

³⁹ <http://www.hughesnet.com/plans-and-pricing/internet-service>, accessed June 2016.

⁴⁰ <http://business.hughesnet.com/plans-and-pricing/internet-service>, accessed June 2016.

Business Package	Internet Speed	Monthly Data Allowance (Business Period + Anytime)	Monthly Price
Select 400	15 Mbps down/ 2 Mbps up	50 GB + 10 GB	\$159.99

Exede Internet also offers residential and business satellite services in Hayward. Residential plans provide 12 Mbps download and 3 Mbps upload. They start at \$59.99 per month for 10 GB of data and go up to 18 GB for \$99.99 or 30 GB for \$149.99. After reaching the monthly data cap, download speeds are reduced to 1 Mbps to 5 Mbps. Exede’s Business Class product provides 15 Mbps download speeds and 4 Mbps upload. There are two separate 30 GB data caps that run from 8 a.m. to 3 a.m. and 3 a.m. to 8 a.m. providing 60 GB total per month.⁴¹

⁴¹ <https://www.inmyarea.com/internet/94557>, accessed June 2016.