

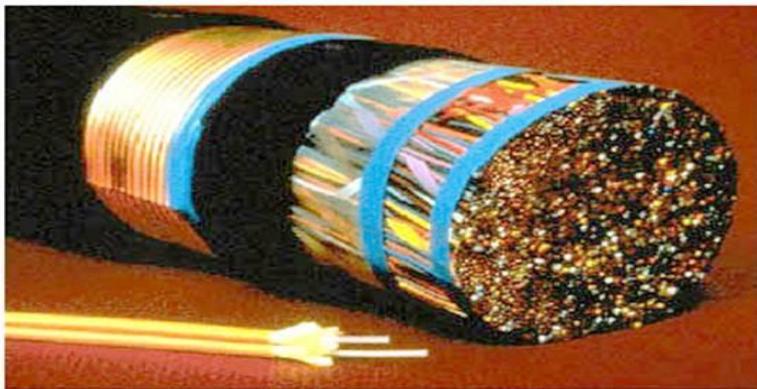
## Appendix A Benefits of Fiber Optics & Axiom Recommendations

Three observations of Axiom's analysis of the region:

- ✓ There is a lot of trunk fiber in Oxford County that is almost exclusively being used for transport (moving data from one point to the next, not serving customers)
- ✓ That fiber is not currently being leveraged to the extent it should
- ✓ Many communities were setting a goal of communicating the benefits of Broadband fiber connections

As part of its final report, Axiom added this section on how fiber optics works and why it is superior technology compared to DSL or co-ax cable copper, which is what is serving the vast majority of the Maine West communities now. In addition, Axiom wants Maine West communities to understand the benefits that can flow from having fiber connections to businesses and more importantly to residences. This section can be used by community and regional policy makers to help citizens understand the benefits of a fiber network, while weighing the cost.

One of the major concerns with fiber systems is the up-front cost. Over time other technologies would need to be replaced, upgraded or deemed obsolete. Fiber would not. Fiber will allow the bandwidth delivered to be scaled as needed, all while using the same fiber distribution network over a period of decades.



**The optical fiber cable in the foreground has the equivalent capacity of the copper cable in the background.**

Just one visual example will underscore the capabilities of a fiber connection versus a legacy copper network connection. With today's technology, one fiber the thickness of a human hair can carry more data than 4,000 top-speed DSL lines.

Homes that are being served by copper, either through DSL from the phone company or with co-ax from the cable company, have significant limitations in service because of how each technology works. In the case of DSL, not only is the driving technology outdated, but the old copper lines are susceptible to corrosion that can severely impact the reliability of a subscriber connection.

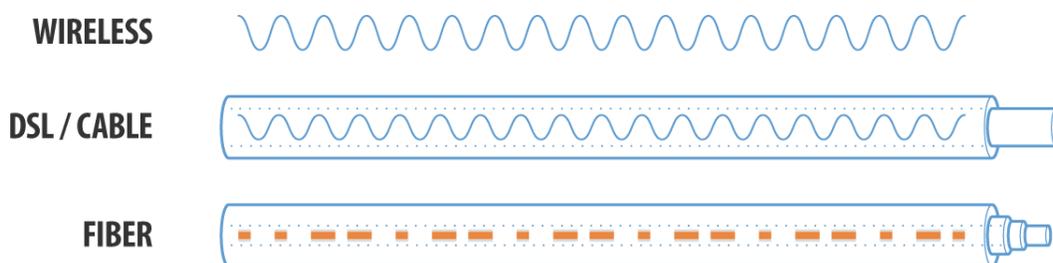
Furthermore, DSL is severely limited in the distance it can push a signal (3-mile maximum), meaning those homes furthest from the telco equipment are faced with connections that often cannot reach even a paltry 3Mbps download speed.

In the case of coaxial cable (co-ax), used by TV cable providers, capacity is still an issue, but for different reasons than with DSL. Compared to a fiber-optic system, cable is not nearly so scalable –

for every step up in speeds, equipment needs to be upgraded both at the home and at the cable plant. Furthermore, cable systems were designed primarily to push data down to the customer, a significantly different model than the emerging needs for telecommuting and interactive video, which require high bandwidth in both directions. Finally, there is a major concern with the fact that cable is a shared system, meaning that the signal strength the subscriber receives is dependent on how much bandwidth is being drawn by other users that are also connected to that line of cable. Cable companies commonly oversaturate their subscriber networks by a ratio of up to 100:1, leading to inconsistent speeds for the end user.

Naturally, questions arise about the capabilities of each technology and these differences should be carefully considered when building a network. Axiom firmly believes that the benefits of having fiber connections to businesses – and just as importantly, to homes – are worthy of consideration, even with the cost associated with fiber.

### How it works is the secret to higher speeds

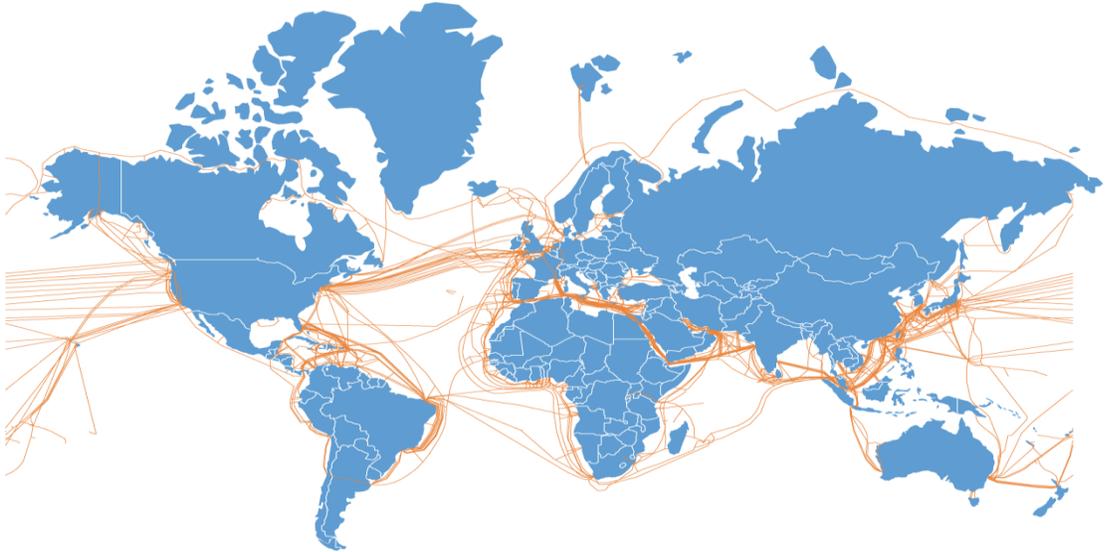


“Broadband” describes the fastest method of delivering high-speed internet to subscribers. While DSL and cable utilize existing phone and TV infrastructure to transmit data as frequency “vibrations” over copper wires, fiber networks transmit data using light over specialized cables that contain glass fiber strands. Light moves at 186,000 miles per second, and this is what enables speeds of 1 Gig (1000Mbps) or much more per connection, 100 times faster than a 10Mbps DSL connection and 10 times faster than a 100Mbps cable connection. In addition, both DSL and cable suffer from the limits of their own technology, making them less than ideal choices into the future.

Wireless is an interesting choice and is certainly being considered in major urban markets where the density of buildings makes fiber optic cabling expensive and complicated. Wireless service, while reliable, is not as reliable as fiber optics and can be susceptible to weather conditions and movement of outdoor equipment due to wind. Wireless also requires a direct line of sight; obstructions are not a friend of a wireless signal. While it has the capability to be as fast as fiber, reliability concerns and reliance on line of sight make wireless installations best suited to very dense urban locations, or certain rural locations where the physical environment allows for reliable, high speed wireless systems, where costs make wireless a serious consideration.

### Like other technology, is it going to become obsolete?

While the future cannot be predicted, all indications are that fiber optics is here to stay for a very long time. Frankly, this technology has already been used for many, many years, which means that there are trillions of dollars of fiber installed globally. A whole industry has grown up around how to utilize fiber to its fullest capacity to make all of our lives better. This industry has proven very good at developing new electronics to push more and more data through existing fiber lines.

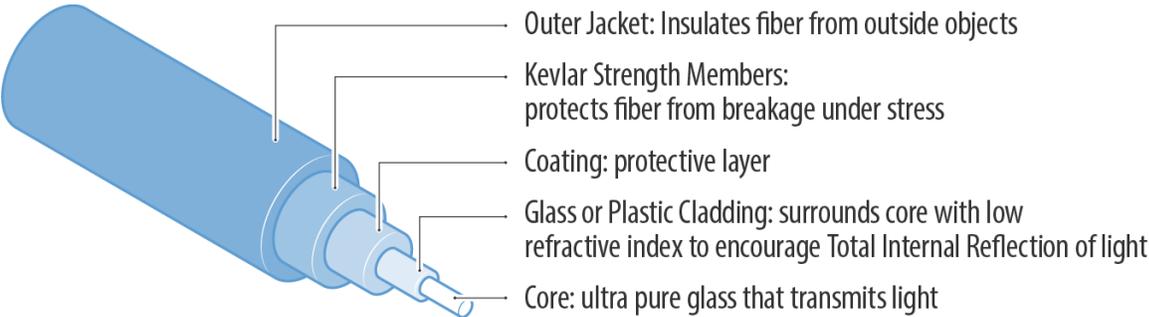


Most people think of fiber as a new technology, but in reality, it has been used for “backbone” connectivity as far back as the 80s, with hundreds of fiber optic cables running across the ocean floor all around the world.

What is new is that fiber is starting to be used to serve homes in places like Austin and Chattanooga and right here in Maine on the islands of Islesboro and Cranberry Isles, where FTTH (Fiber-to-the Home) networks are being deployed. Because of the extensive network of fiber already deployed and continuing to be deployed, it is very unlikely that there will be major shifts in market forces that would make fiber optics obsolete. Most telecom observers believe that 5G cellular technology is many, many years away from possibly replacing even a traditional DSL or cable connection.

**What is in a fiber-optic cable?**

An individual optical fiber (the size of a human hair) is surrounded by several layers of material that strengthen and protect the fiber. A fiber-optic cable can have any number of “fibers” ranging from 1 to several 100s.



**Benefits of Fiber Technology**

**Speed and Capacity.** Many experts say that FTTH connections are the only technology with enough bandwidth to support the projected consumer demands over the next decade.

**Future proof.** Because of fiber’s capabilities, new technological innovations are being invented every day to utilize fiber’s superior ability to transport tremendous amounts of data at blazingly fast

speeds. Technologies such as 3D holographic high definition television and gaming will someday be everyday items in households around the world. FTTH will be able handle the estimated 30 gigabit-per-second needs of such equipment. And this is just one technology. Think about the new ways that the internet can be used that seem commonplace now but were not even conceived of 10 years ago.

**One delivery system.** Right now a consumer can receive telephone, video, audio, television and almost any type of data transmission using a single seamless FTTH connection. That trend will continue as consumers are given increasing array of a la carte choices for how they receive their various communication and data and streaming choices. Subscribers are also realizing that receiving bundled services through a fiber connection can save money.

**Reliability.** Fiber is the most reliable connection. In broadband surveys across the state of Maine, the #1 complaint is reliability. An internet connection is a necessity, not a luxury. When connectivity is interrupted or slowed down unexpectedly or inexplicably consumers are furious that they cannot accomplish an on-line task, leading to a significant loss of productivity or time.

### Direct benefits to Communities

**Job Creation-** There are many examples of fiber networks creating jobs by either supporting existing businesses or attracting new ones.

**Business Attraction-** Business attraction means businesses that are looking for the kinds of connections that can move large amounts of data, quickly. These businesses include architects, designers, banks and other heavy internet users.

**Entrepreneurship-** Fiber helps induce young people to locate and work from anywhere.

**Telemedicine-** The medical field and how patients and providers interact is undergoing seismic changes. One of those changes is the way patients are able to be seen, treated, monitored and increasingly given tools to manage their own health care, right from their home. A fiber connection has the capacity to manage these data transmission uses, which in turn facilitates seniors aging in place.

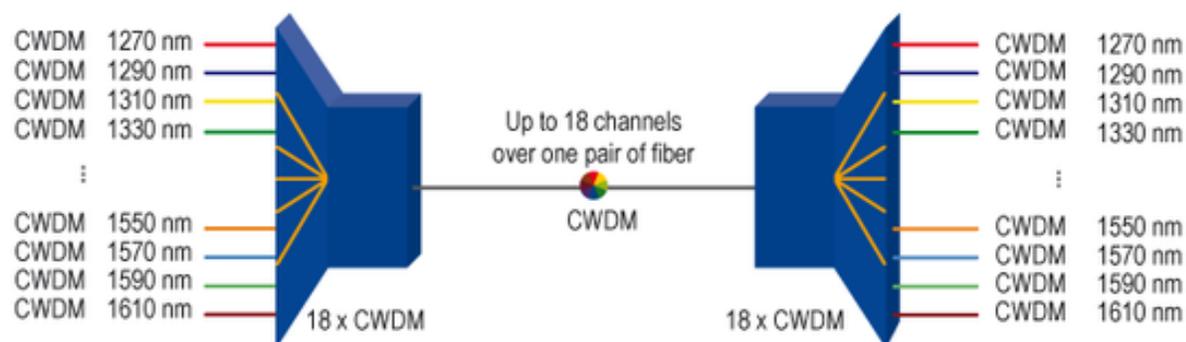
**Increased Home Values-** A Broadband Communities study reported that FTTH networks increase the value of a \$300,000 home by an average of \$5,000-\$6,000. Another study by the FTTH Council in conjunction with the University of Colorado showed that homes with a FTTH connection are worth, on average, 3.1% more than homes that do not have a fiber connection.

A fiber network can be leveraged to help communities differentiate themselves in positive ways. Letting the world know that Maine West is on the cutting edge of realizing what homeowners and businesses are demanding to help them work or play online more efficiently, drives prominence for the towns in Maine West and encourages both in-migration and business growth.

## Proposed Fiber Equipment

### CWDM (Coarse Wavelength Division Multiplexing)

Axiom's cost estimates use a fiber technology hardware called Coarse Wavelength Division Multiplexing (CWDM). This system allows up to 18 connections over a single fiber strand by having each connection operate on a separate light wavelength.



This allows multiple premise connections operating over a single fiber strand that can carry up to 10Gbps (10,000Mbps), depending on the hardware used.

What does this mean for Maine West?

- Saves cost, because the size of trunk cable has potential to be sized differently (smaller)
- Allows for inexpensive connections up to a Gigabyte to each business or home and can increase to 10Gigs (10,000Mbps) with off the shelf hardware upgrades. Even 10G CWDM transceivers are relatively inexpensive today at about \$100/each
- Scalable, allows for a single fiber to serve up to 18 businesses or homes and can easily accommodate years of new growth with just a few additional strands of fiber

The CDWM solution saves cost, but not at the sacrifice of performance. First, the trunk line that will serve as the main line of fiber that is used to create “drops” (fiber connections) to each premise does not need to be as large, saving space, reducing tension and weight on the existing utility pole infrastructure that the trunk line would be hung. Using CDWM allows the trunk line size and weight and cost to be reduced, while still offering excellent scalability. Weight and tension matter when considering poles can cost up to \$3,000 a piece to replace. Every 10 poles of replacement cost that can be avoided saves \$30,000. The size and weight of the fiber cable can have a direct relationship to potential pole replacements.

With inexpensive optics, up to 1Gbps (1000Mbps) could be offered to each home today. Unlike cable or even other fiber technologies (xPON), fiber is not a shared connection, the network truly supports a full Gig to each home. As time passes, a day may come when more than a Gig of service would be needed at each premise. At that time, optical equipment can easily be switched out to offer up to 10Gbps (10,000Mbps) of service for a robust upgrade that is both easy and inexpensive.

When looking at future proofing a network, this design allows for almost unlimited speed and capacity increases without changing the actual fiber deployment on the street. As fiber has become the chosen technology for connectivity, equipment providers continue to innovate by changing the hardware on each end of the fiber to increase capability, without having to reinvest in a whole new system. Axiom is comfortable recommending a system that will easily last 20 years or more with relatively small, if any, equipment upgrades over the life of the fiber.

In short,

- Fiber is a long-term investment in a community's future
- Fiber supports 21<sup>st</sup> century economic opportunities
- Fiber leapfrogs communities that are left behind to the front of the pack
- Fiber, over the long run, is a less expensive technology

Axiom Recommendations:

- Build pieces of the regional fiber recommendations, as funds become available
- Implement any of the proposed town fiber networks:
  - Bethel/Newry
  - Oxford High Capacity Route 26 corridor
  - Roxbury- Ellis Pond
  - Greenwood Lakes Region
- Install HotSpots across a number of communities to create footholds of demonstration projects about the need for better connectivity
- Consider wireless projects as communities express interest and cost sensitivity matters

