Roadmap to Building a Community Gigabit Network

A step-by-step guide for Maine municipalities

By Fletcher Kittredge, CEO, GWI

Introduction:

Improving Maine's Broadband Challenges with Community Gigabit Networks

The U.S. has fallen from first to 25th in broadband technology while other countries are using public money to build new all fiber networks to deliver Internet access to homes and businesses. In Maine, our broadband Internet access is significantly inferior to other states and the problem is getting worse. Our technology isn't deteriorating, but the rest of the world is developing broadband capacity at a far faster rate. As the economic significance continues to impact Maine's homeowners and business opportunities, at GWI, we're always exploring solutions. We know that the technology is well understood and widely available – we need to build all fiber community networks throughout Maine.

In Maine, Rockport and South Portland are two municipalities that have started building municipal fiber networks and a number of other towns are exploring building their own networks. GWI is a partner in building Rockport's initial municipal fiber network and is also partnering with South Portland.

Did You Know?

Gigabit Fiber to the Home connections offer homes and businesses broadband connections that are 100 times faster than typical connections?

We are excited to see more Maine towns investing in the technology available in Maine to improve broadband access. We know that Gigabit networks can bring great value to a community, but like any technical public works project, there are many ways they can go wrong.

This guide is designed specifically for Maine municipalities and (other interested community members) to serve as a roadmap to insuring your project's success. Skipping steps will only diminish the likelihood of your success

With the exception of the legal and regulatory sections, it is generally applicable to other states, as well.

Step 1: Identify Goals

The first and most important step is to determine your community's high level goals of the project. ***High level goals should not be technical goals***. They should identify the benefits that your community expects from building the network.

For example, some Maine communities have identified goals such as:

- A major employer needs gigabit access in order to remain in the community
- Our economic future is with the digital and creative economy
- We need to connect our town offices, schools, and libraries
- We want to attract manufacturers to the business park
- Our residents want to save money on their video bills

Infrastructure is a shared resource and the more people you have using the same shared resource, the lower the cost for each person.

At least initially, it is not necessary to connect the entire community. You can start small, learn from an initial project and then expand to the entire municipality. A good place to start in developing goals is to review your municipality's comprehensive plan.

After you have developed your high level goals, we have observed that the following technical goals apply to any project. These goals are driven by our experience that: ***infrastructure is a shared resource and the more people you have using the same shared resource, the lower the cost for each person***. Eventually, all businesses and residences will be connected to the network. By designing the network in advance to be shared by everyone, your long-term cost will be much lower.

- **The system should be designed to be expandable to serve the entire municipality and surrounding regions.** By partnering with other municipalities, you may be able to lower the costs for your town. With minimal added initial cost over building a basic downtown system, you can significantly lower

the costs of extending the system to suburban and rural areas of your town.

- **The system should be designed to connect every building passed on the route.**

- **The system should be designed to be an "open access system"**. An open access system is one in which there are many service providers sharing the same infrastructure and competing to offer customers service. In an open access system, the emphasis is on wholesaling to service providers on terms that are "just, reasonable and not unreasonably discriminatory." The providers then supply your businesses and residential customers.[1]

- **The default design should be a dark fiber system**. In a municipal dark fiber system such as Rockport or South Portland, the municipality only funds the capital investment for the fiber and does not fund the capital investment for any equipment nor does the municipality have any significant operating expense or responsibility. Instead, service providers are responsible for providing and operating the equipment. This reduces the municipality's capital cost by more than half and avoids the vast majority of operating expense. Dark fiber networks only work as open access networks. These benefits, in terms of capital and operating expense, come with a risk: if there are not enough service providers interested in providing service on the network, a de facto monopoly can develop, or worse there can be no service provider at all! In Maine, the risk of either of these cases is much less for a municipality connecting to the Three Ring Binder (3RB).[2]

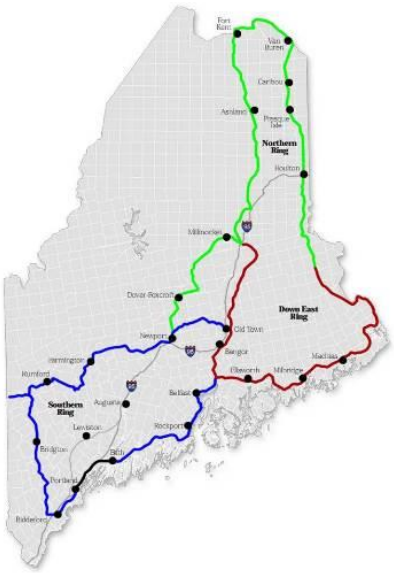

Figure 1: Maine's Thrree Ring Binder Middle-Mile Open Access Dark Fiber

- **Reliability is as important as speed**. Each day, the network is becoming more vital to business, healthcare and public safety. Network reliability should be designed in from the beginning.

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[1] An in-depth discussion of open access systems can be found in ***Business Models for Municipal Networks in Maine***(to be published February 16, 2015).

[2] The Three Ring Binder(3RB) is a federally funded, very large, open access middle mile fiber optic network spanning most of Maine. Dozens of service providers use it and can offer service to customers connected directly or indirectly to the 3RB. Further discussion of the 3RB can be found in ***Business Models for Municipal Networks in Maine*** (to be published February 16, 2015).

Step 2: Gather Data

Gather Capacity Inventory and Demographic Information

Great data is necessary to build a great network. The more detailed information you can make available to community developers, project planners, and network designers, the more likely it is that the goals for the network will be met. Providing capacity inventory and demographic information will allow everyone to evaluate whether or not the business model will be a good match, will insure that the network will be designed correctly and will help keep capital and operational costs to a minimum – all to the benefit of the public.

Important data includes:

- An assessment of current network assets in the community - All carriers should be surveyed
- Municipal and educational telecommunications needs assessment
- Business demographic information and telecommunications needs assessment
- Residential demographic data
- GIS information on parcel data, roads, natural gas lines, sewers, water lines and utility pole locations
- TIF zones
- New market tax credit zones

Step 3: Build Support

Build Constituent Support

It is vital to build constituent support before undertaking a municipal network. A public project should have a majority of the citizens supporting it. In any community, there are going to be technology enthusiasts who understand the benefits of gigabit networks. These enthusiasts can make good community ambassadors for the network, communicating with their neighbors and stimulating demand, but they are usually a small segment of the population. Convincing late adoptors is necessary too. As we touched on in the business model discussions, it is important to reach a “acceptance rate” where at least half of the population is supportive.

As you build support, it's also vital to identify anchor tenants, such as:

- Education
- Government
- Healthcare
- Manufacturing
- Other Large Employers
- Non-profit
- Residential (condo developments, MTUs)

Step 4: Select a Business Model

Getting the business model right is an entire topic in and of itself. For that reason, GWI will release a companion paper to this one: ***Business Models For Municipal Networks in Maine*** on February 16, 2015 that explores case studies of actual Maine towns. What follows is a brief overview.

It is possible the best business model is a partnership between the municipality and one or more for-profit or non-profit organizations. In that case, your municipality will likely benefit from issuing a Request for Information (RFI) in order to identify the best partner[s]. The partners found, and their proposed solutions to the needs identified in steps 1-3, will shape your ultimate business model. For that reason, there are iterations between steps 4 and 5; first identifying a potential business model involving partnerships, learning who wants to partner and then adjusting the business plan. In that case it is best to start exploring business cases first, and then find partners that match the potential business case.

Potential Business Models

There are a variety of business models that you may select based on a number of different ranges of options. One range of options is along the public, public/private and private ownership models. Another range is the amount, if any, of subsidy to be provided to customers. It can range all the way from free service for everyone to subsidies for low income to all subscribers pay the full cost of building, capitalizing and operating the system. A third range of

options is between a closed (monopoly) or partial open access or full open access network. There are a wide variety of methods of identifying funding sources.

Finally, a municipality can initially build out service to a section of the municipality or some limited set of customers, such as businesses, or it can chose to serve all citizens and businesses at once. It is obviously a smaller task to start with a smaller system, but is it also more difficult to convince the public to fund a system that only serves part of the town.

Revenue Models

Americans are accustomed to paying a monthly fee for telecommunications: cellphone, video, Internet access, telephone. The path of least resistance is to fund a municipal fiber system through monthly fees. In an open access dark fiber model, the service providers that are leasing dark fiber from the municipality would pay the monthly fees. In a closed access system, the end user would pay the municipality the monthly service fee. Depending on penetration rate and the price of the monthly fees charged, some or all of the operating costs and capital costs are covered. If all costs are covered with sufficient extra for rapid capital payback and profit, then a pure private system is a possibility. If the costs are only partially covered, if the capital payback is more than a few years or if there is no profit, a public/private partnership is probably necessary.

Sources of Funding

If your system is initially small, there is a great deal of flexibility around funding. Some sources are TIF funds, municipal bonds, grants, and anchor tenants. In the case of an anchor tenant, an initial payment in advance for services can provide part or all of the initial funding or a contract of sufficient strength to allow for bank funding.[3]
For larger public or public/private projects, some of the capital can come from the above sources but it is unlikely they will suffice. A municipality raising the capital through bond funding is necessary in that case. The costs of the funding are directly related to the structure and soundness of the business model. This is a complex topic that will be discussed in detail in ***Business Models for Municipal Networks in Maine***.

[3] See: ***Business Models for Municipal Networks in Maine***, the Rockport and South Portland case studies (to be published February 16, 2015.)

Step 5: Find Partners/ Vendors

Finding Partners and/or Vendors

During the process of identifying goals and selecting a potential business model, your municipality may feel that you want to handle everything for yourself -- a pure publicly-owned network model. Even in that case, it is worth it to at least preliminarily scan the horizon for potential partners. It satisfies any due diligence questions later and potential partners are probably also potential vendors.

You can issue a Request for Information (RFI) and distribute it to a large number of entities (for-profit and non-profit), outlining a general problem to be solved and requesting from responses from the entities on their ability to solve the problem with outlines of suggested solutions. After your municipality has completed steps 1-3 and step 4 at least initially, it makes sense to put out an RFI to discover what potential partnerships exist and the capabilities of potential vendors.

Helpful Tip:

Issuing an RFP to a large number of entities helps you discover potential partnerships and the skills of potential vendors.

At a minimum, your RFI should include:

1. A clear description of your municipality's goals for the project including concrete requirements (open access, minimum speeds, quality of service, coverage, public buildings to be connected, price range, etc.)
2. As much demographic information as possible from step 2.
3. A clear description of business models your municipality is willing to accept. The RFI might include a statement that "the town is open to suggestions". However, if certain aspects are off the table for your community, save everyone time by clarifying these aspects up front.
4. A defined format for responses so that it is easy to compare solutions proposed by vendors.
5. The required responses should cover all the capabilities necessary to insure vendors successfully supply the municipality's needs (past projects, references, management team, financial resources.)

Step 5: Find Partners/ Vendors

Negotiate Partnership/Letter of Intent

After the responses from the RFI are received, review them and identify any ideal matches for potential partners. If so, negotiate and sign a Letter of Intent (LOI). The LOI is to cover the time period it takes to finalize a partnership contract. Inevitably, the contract will not be finalized until monies are expended to do a detailed design and a RFP and procurement process.

Issue RFP

When your municipality has a concrete business plan in place and has a matching detailed system design and operations plan, your next step is to issue an RFP (Request For Proposals) for the different aspects of a system. The RFP needs to follow the legal procurement process for the municipality and must include enough detail for vendors to submit binding bid proposals. RFPs cover these aspects of the project:

1. Engineering, Procurement and Construction RFP
2. Design RFP
3. Construction RFP
4. Operation and/or Default Provider RFP
5. Maintenance RFP

In the case of a dark fiber network, there is no need for an operational RFP because operations will be the responsibility of the service providers. In that case, it is necessary to have a vendor be the “Default Provider” and commit to offering a basic set of services at agreed upon prices.

Step 6: Select a Vendor

Selecting Construction/Operations Vendor

Based on the RFP responses, pick vendors for the different aspects of designing, building and operating the system. Select the vendor that is most likely to build a successful system rather than offer the lowest price.

Step 7: Oversee Construction

Overseeing Construction

The quality of implementation makes the difference between the success and failure of a community infrastructure project. Primary oversight of the project will belong to the EPC vendor, but your community needs to stay involved. Meet regularly with the vendor, ask many questions, and physically inspect the project as it is built.

Figure 2: Construction worker lashes fiber to poles in Rockport.

Step 8: Operations, Sales & Marketing

Operations, Sales and Marketing

Running a network is as large a task as building one. The size of the task for your community is very different depending on whether you build a dark fiber network or your community operates the network itself. Given the very different paths, it makes sense to look at the two cases separately.

Dark Fiber Networks

Operating a dark fiber network is simpler because there is neither equipment nor moving parts. There are four tasks:

1. Negotiate and manage relationships with lit service providers
2. Keep an inventory of the dark fiber
3. Dispatch to repair broken fiber, and
4. Bill service providers for fiber used

Dark fiber inventory can be performed by town officials or outsourced to companies like GWI or MFC. The good news is that dark fiber infrequently needs repair. There are a wide range of outside plant companies such as Icon, NextGen, OnTarget, and Green Mountain that can be on retainer to repair dark fiber breaks.

Billing for dark fiber usually happens on a monthly basis and is driven off the fiber inventory. Usually bills are simple and only a small number of large bills are generated to service providers. The bills are large both in relative amount and in detail: each fiber used needs to be identified as a separate line item.

The downside to the ease of operating a dark fiber network is the risk of not having enough lit service providers. It is vital that there be at least one **Default Provider**, an ISP that has made a long term commitment to use the network to provide a defined set of services to all customers at some mutually agreed upon price. If you can have multiple service providers competing for your citizens' business, then your citizens will get the best of service at the lowest price. If your community is well connected to the 3RB, there is a high likelihood of there being a wide variety of companies willing to offer service via your dark fiber network. Under current Maine and federal law, municipal dark fiber networks seem not to be regulated utilities.

Lit Service Networks

When a community offers lit services, the task is significantly larger than initially building the network. All of the tasks are ongoing and your community will need to take on the responsibility for at least two decades. It is probably not practical unless a community has at least 5,000 customers. The following is a brief breakdown of the tasks required. Note that all of these are ongoing tasks that will need to be performed for decades. The municipality will either want to start a separate corporate entity or a significant municipal department to act as the broadband utility.

1. **Marketing:** Developing products and product packages and promoting them to potential customers; track competing services and develop market positioning in relation to competitive services. As the financial viability of the network depends on a sufficient number of customers using it, marketing is vital. Communities that provide lit services and are not good at marketing will likely fail.
2. **Sales**: Convincing customers to buy service and answering questions about the service. Sales is as vital as marketing.
3. **Provisioning/deprovisioning/installation/uninstallation**: Updating internal systems when a new customer or service is added and when services and customers are dropped. Physically installing and uninstalling service.
4. **Technical Support**: Answering technical questions and fixing technical problems of individual customers.

5. **Network and Systems maintenance and trouble response**: Fixing problems that affect a wide range of customers or are system-wide; upgrading the network or systems such as routers, switches, and servers; routine maintenance on all of the above.
6. **Outside Plant**: Maintaining the outside plant such as fiber, pole attachments, multi-ports and drop cables; extending that network as necessary.
7. **Customer Support**: Answering customer's questions regarding bills, accounts, address changes, etc.
8. **Billing and Accounting:** Generating bills, accounts receivable and payable.
9. **Taxes, regulatory, and legal:** Under current law, the municipal company or department would probably be a regulated utility under state and federal law. This area of regulation is undergoing significant ferment and will need to be monitored and responded to.

Competition is probably much more of a factor for community lit service providers than for community dark fiber networks. Your community will need to do a superior job in the above components to compete with other providers.

Network Upgrades in Response to Technology Evolution

How will your community deal with the evolution of technology?

Broadband networks are "technical infrastructure". Like most technologies, technical infrastructure is prone to evolving significantly over time. It is difficult to predict how long in advance the rate and direction of evolution. Any plan for a community network should include methods to deal with the evolution. Once again, there is a split in the path between dark fiber and lit service networks. The evolution of fiber is slow; the evolution of lit services is much faster. For a dark fiber network, the burden of technology evolution network falls on the service provider, not the community.

One technique for dealing with technical evolution is to build equipment depreciation due to technological

obsolescence into your business plan. Over the last twenty years, we have found that we usually retire equipment due to obsolescence, rather than it wearing out. We have learned that CPE such as ONTs, wifi stations, customer routers, and modems need to be replaced after three years, service provider equipment such as servers, switches, and OLTs have a useful lifetime of five years and equipment such as routers, WDM equipment have an useful lifetime of seven years. OSP equipment such as fiber, pole attachments, connectors and multiports have a useful lifetime of twenty years. With these depreciation schedules, it has been *very* rare to take equipment out of service before it is fully depreciated.

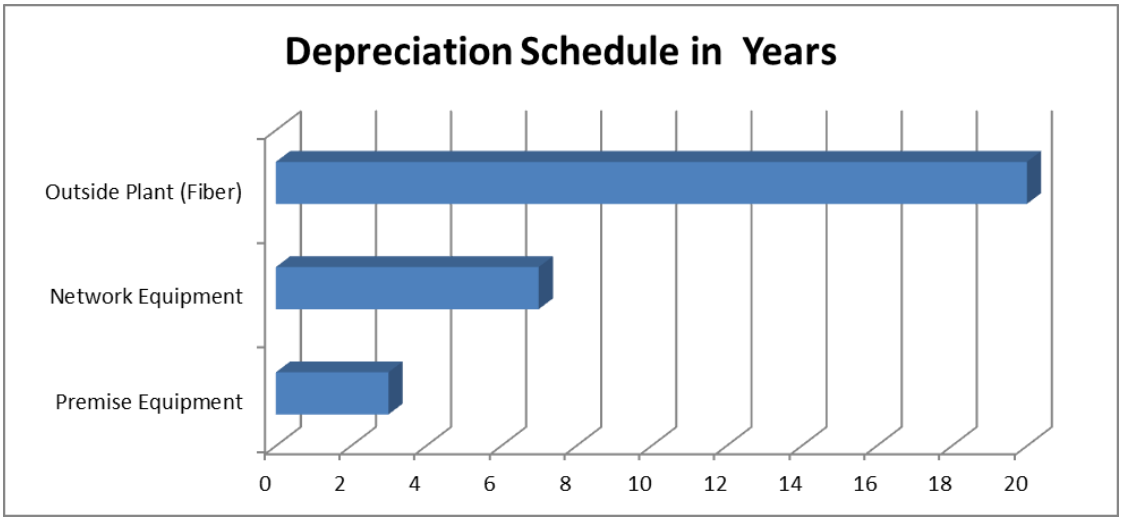

Figure 3: Depreciation Schedules of Broadfband Network Components.

A second technique for dealing with technology evolution is to develop a technology roadmap that predicts the future for a rolling five to seven years and maps out how to respond to the changing technology. The roadmap is then updated periodically depending on changes in existing technology and the competitive landscape. For community lit service providers, the roadmap should be updated at least every six months. For community dark fiber networks, every year or two should suffice.

Network Expansion

In addition to technology evolution, the network will need to be upgraded in response to growth. In expansion, there is not much difference between dark fiber and lit service networks. There are two types of growth: expansion of footprint and more connections in the existing footprint. Both require expanding the fiber network. Lit service providers will also need to add more equipment but conceptually that is not much difference.

One of the greatest failings of past and current networks is failing to planning for future network expansion."

Expansion in footprint takes two forms. The first is expansion internal to the community. Perhaps the network starts out only serving one part of the community, say the business district, and then is extended to other parts of the town. What is important in inter-community expansion is to make sure the fiber connectivity architecture is planned from the beginning to serve all of the community. Enough backbone fiber should be provisioned. Huts and central offices should be sized to handle enough equipment to serve all of the community, or at least designed to be inexpensively expanded.

The second type of footprint expansion is outside the community. Your community and your vendors should consider this during the business and technology plans development phase -- how will your community connect to surrounding communities in the future?

Another way that a network will expand is adding more connections internal to the existing footprint. The network should be designed to serve all existing residential and commercial structures in a community and include a reasonable guess at expansion for the community. A municipality's comprehensive plan is a good place to start for predictions of future growth. In designing for internal expansion, it may be the most cost-effective path to construct connections "just in time." Even in that case, the network connection architecture should be designed so that it is expandable to all structures. Sufficient slack loops and backbone fiber count should be provided and locations of additional splitters, huts, multi-ports should be

designed into the network in advance.

One of the greatest failings of past and current network designs is to build only for seldom last for their anticipated and budgeted lifetimes and need to be replaced. For example, failed municipal networks are those that have been built only to serve municipal buildings, only to serve some commercial properties, only built to serve part of a town or only to serve a particular transmission technology. Not planning for the technology evolution and network expansion is imprudent and a waste of community resources. Infrastructure is a shared resource and the more people sharing it, the more cost effective it is. A design that does not maximize sharing is an inferior design.

Step 9: Decommission or Replace Network

Decommission or Replace Network

Everything has a beginning, a middle, and an end. A good plan should encompass the full lifetime of a project. A business plan should include potential exit strategies. A technical design should include the process of decommissioning or replacing the product.

Given that fiber networks are designed to last a minimum of two decades and with proper maintenance, we can reasonably expect them to last two or three times as long, planning for decommissioning may seem like an unnecessary theoretical exercise. The old telephone network lasted for close to a century. The railroad network is over 150 years old and seems to have a lifetime extending far into the future. Our road network has been around for hundreds of years and we have the expectation it will last for hundreds more. However, things don't always turn out as we expect. Unexpected "black swan" events can happen, both positive and negative. It is only prudent to plan for as many outcomes as possible. This is particularly necessary in a technological field. We can't predict the future, but it is worth it

to try. In this section, we discuss a few possible scenarios that should be incorporated into your technology planning.

1. Network Consolidation

Given the history of the last hundred years, the most likely scenario is success and widespread adoption of multi-gigabit fiber technologies. In a future in which every home and business is connected via gigabit fiber, the next natural step would be network consolidation.

The nature of networks is that there are huge economies of scale and it is much cheaper per customer to run a very large network than a very small network. For that reason, the telegraph, railroad, telephone, electricity, and cable TV networks all started out as small, isolated networks that went through a period of consolidation to large, efficient networks. If that is the case in the gigabit fiber world, a day will come where probably the best thing might be for a community to consolidate its network into a larger network with other communities or to sell its network on favorable terms to a large private operator.

In planning for this outcome, your community should make sure that it designs its business plan and technical design in such a way that the transaction is as inexpensive and convenient as possible. The legal structure of any entity and funding should be designed in such a way that a larger organization, public or private, can take on the network. The technical design should as much as possible follow industry standard practices—this is no place to be needlessly innovative –and envision a potential future that includes consolidation with an outside network[s].

2. New Communication Technology Replacement

There is no practical or theoretical potential communications technology replacement for fiber optic networks, at least for the next few decades. However, further out it is not unlikely that unimagined communications technologies may evolve. For example, something like superluminal communication[4]. In that case, the network would probably gradually become outmoded and be completely replaced by new technology. In that case, plan for the fiber and equipment to be decommissioned and any corporate or accounting entity wrapped up.

Business Failure

[4] According to Wikipedia: "The scientific consensus is that faster-than-light communication is not possible and to date superluminal communication has not been achieved in any experiment."

It is possible that expected cash flow may not materialize either because expenses were greater than anticipated or the demand curve is less than anticipated. In that case, it is important to have backup plans. Your backup plans might include additional funding to cover any shortfall or unexpected expenses. In the case of a dark fiber network, if the failure is no acceptable default provider materializing, the backup might be the community becoming a lit service provider. That decision should not be undertaken lightly for all the reasons outlined above.

Conclusion

Careful planning and oversight is crucial to deploying a successful municipal fiber network. Diligence and transparency between all of the parties involved will allow for a streamlined process. Though the steps referenced in this paper are not mandatory, we feel that they are **all** key components in the development of a municipal network. If these steps are followed, risk is reduced and success is likely.

Conclusion

Broadband is a Necessity in Staying Competitive in the Digital Economy

The topic of broadband expansion continues to gain attention, including from President Obama who recently acknowledging high-speed broadband as a "necessity" in staying competitive in the digital economy. In Maine, towns of all sizes and in all locations of the state are beginning to think about future proofing their locales through broadband. The 127th Maine Legislative session alone has over 30 bills pertaining to broadband. The time to begin thinking about your community and its plan for infrastructure in the future is now, but make sure not to make any hasty decisions.

We hope that you will take the time to read our next paper, "**Business Models for Municipal Networks in Maine**(to be published February 16, 2015). " That paper covers a number of projects in Maine in various stages of completion. It also examines completed projects, both successful and unsuccessful, from other parts of the US.

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Fletcher is the CEO and founder of GWI. Fletcher grew up in Arundel, Maine and went to Colby College, where he majored in English. A passionate advocate for broadband growth and network neutrality, Fletcher serves on the ConnectME advisory board in addition to his role at GWI. He led GWI's efforts to obtain a $25 million Federal grant to deploy 1,110 miles of high capacity fiber optics in rural Maine as part of the Three Ring Binder project, later transitioning those funds to independent Maine Fiber Company in order to foster competiton and lower broadband costs for rural Maine. In 2011, Fletcher was recognized by MaineBiz as Business Leader of the Year for his leadership of GWI and bringing funding for the Three Ring Binder to Maine.

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Make Your Voice Heard

Let's work together to build a broadband infrastructure that's worthy of a leading spot among our national peers.

Please visit:
www.gwi.net/communitygigabit

and join our email list of legislators, business owners and concerned Mainers who want to work toward our goal together.