

Cover Letter

September 30, 2015

Mr. Rich Beadles
Technical Services Manager
City of Madison

Via e-mail: rbeadles@cityofmadison.com

Subject: Proposal to prepare a business and strategic analysis of a citywide fiber-to-the-premises (FTTP) initiative

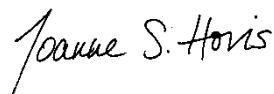
Dear Mr. Beadles:

CTC Technology & Energy (CTC) is pleased to provide this proposal to develop a fiber-to-the-premises (FTTP) analysis for the City of Madison. We will be the City's independent, objective adviser—and will be guided by the City's goals, priorities, and risk tolerance.

We do not perform “cookie cutter” work, and do not view our clients' goals as a series of cookie-cutter needs. Engaging with CTC means receiving customized analysis and the level of time, consideration, and care required to provide you with the answers you need. CTC is widely recognized for FTTP engineering and business analysis and has a track record of success supporting municipal government clients.

Please do not hesitate to contact me if you would like to discuss this proposal further. We look forward to working with the City on this important project.

Best Regards,



Joanne S. Hovis | President

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1. Scope of Work

CTC proposes to develop a detailed business and strategic analysis of a potential citywide fiber-to-the-premises (FTTP) network. **At the heart of the project will be our analysis of three primary approaches—an open network model, a City partnership with a private entity, and a City utility model.** Our comprehensive project report will explore options and deliver actionable data, insight, and recommendations.

We will be the City's independent, objective adviser—and will be guided by the City's goals, priorities, and risk tolerance. For legal services related to evaluation of legislative barriers, we include on our team Kenneth Fellman, a partner in the law firm of Kissinger & Fellman, in Denver. We have worked extensively with Mr. Fellman on projects nationwide over many years

Task 1: Facilitate Kick-Off Meeting

As a preliminary step, we will conduct an on-site strategy session. Our project team will meet with City staff to discuss project goals and objectives, review relevant maps and documents, and establish project parameters.

CTC will present an overview of municipal fiber projects in the U.S. and Europe and describe ways in which these are instructive of both risks and benefits given the project objectives.

Specific agenda items will also include the following:

- Identify project stakeholders
- Discuss the City's goals and objectives
- Review perceived project strengths and weakness from the City's perspective
- Review range of potential business models (e.g., City utility, public-private partnership, open network)
- Discuss the range of potential risks to the City (e.g., financial, political, legal), and the level of involvement the City is interested in exploring
- Identify range of City telecommunications assets (e.g., Metropolitan Unified Fiber Network) and other infrastructure available to support a citywide network
- Review the range of potential "off-the-balance sheet" benefits that may accrue to the City, including:
 - Economic development
 - Community development
 - Educational achievement
 - Other
- Review emerging public-private partnerships (PPP) and balance of risks and rewards
- Discuss potential services, market positioning, and customer segments

- Discuss existing and anticipated voice, video, and data providers in the region and their likely reaction to the proposed fiber network
- Discuss the potential impact of competition from incumbent operators and new technologies
- Review potential users and markets for new and enhanced connectivity capabilities enabled with fiber, including:
 - Business segments (needs by type and size)
 - Cottage industries supported by economic development
 - Home use (personal and business)
 - Education (e.g., increased capabilities and access in students' homes)
 - Multi-dwelling units
- Review market conditions influencing a City fiber business
- Review project schedule, key milestones, and deliverables
- Review Geographic Information System (GIS) data sets and mapping information
- Review available information to assist with the inventory and asset assessment

Task 2: Prepare conceptual network routes and infrastructure requirements

Based on industry best practices and the parameters established during our kick-off meeting, CTC engineers will develop a recommended system-level network design that incorporates and expands on the Metropolitan Unified Fiber Network (MUFN).

We will include in our design the technical elements that we deem necessary to achieve the City's goals. We will also recommend fiber routes, locations for equipment and points of connection, and ways to leverage existing connectivity resources to achieve the network's goals and objectives.

This task will inform our analysis of the City's potential implementation costs and schedule, and maintenance requirements and costs.

We will seek to maximize the City's expertise and its existing infrastructure. Accordingly, we will meet with City staff from relevant departments to understand their level of preparedness, identify any areas where equipment and training may be required, and develop a strategy for making best use of the City's resources in a potential network deployment.

We will identify least-cost routing for a range of potential fiber topologies, and will consider construction and design practices to minimize overall cost, including planning construction in conjunction with capital improvements in the rights-of-way (e.g., road work, sidewalk replacement programs).

To be clear, we will not be providing a blueprint-level network design. Rather, we will be providing a conceptual design, high-level maps, and a system-level overview of the potential infrastructure—which in turn will become a roadmap for future decisions, including detailed engineering and contracting with private sector service providers.

Task 3: Develop technical specifications and cost estimation

Based on the conceptual network routes and infrastructure requirements developed in Task 2, we will develop technical specifications and high-level capital and operating cost estimates for the construction, operation, and maintenance of the fiber infrastructure.

Both our technical specifications and our cost estimates will reflect a network infrastructure of the type that can support and attract service providers. Reflecting the City's stated interest, the technical specifications will also support "open" network operations.

Our cost estimates will reflect the dramatic changes in fiber construction prices over the past few years, so we expect that the estimates will vary from the City's previous investigations related to fiber feasibility.

We will develop high-level cost estimates on a baseline set of fiber routes, including the cost to connect to third-party fiber providers at Internet points of presence (POP) for obtaining ISP service.

We will also identify incremental costs for enhancing construction methodology to include additional conduit capacity and access points to facilitate reduced-cost construction for potential future expansion and site additions. And we will identify areas of risk and a likely range of costs and schedules.

In this task and the following task, we will also evaluate and provide recommendations on issues related to the operations and management of City infrastructure.

Task 4: Analyze options for ownership and operational structure

Our report will consider a range of business and operational models that might support the City's next steps and inform an implementation roadmap—while creating an environment and a sense of incentive that will attract private sector participation. Throughout this task, we will be weighing advantages and disadvantages, and the impact of various choices and assumptions on the City's business planning.

Our analysis of potential business models—with a focus on the feasibility of a City utility, an open network, and the City partnering with a private entity—will reflect our understanding of both the City's desired role and its risk tolerance.

We will bring to this engagement our experience in identifying the challenges of FTTP network implementation—and our realistic approach to assessing project risks. We will be very frank about the level of funding needed. Over the past 15 years, we have seen communities raise public expectations very high before clearly understanding the challenges of fiber financial models. This can be very disappointing to the public and politically challenging in the event that it does not work out. We will help you moderate public expectations and bring a dose of reality to the plans.

CTC will evaluate staffing considerations, risks and benefits, policies, and financial considerations to enable the City to consider which model best suits its needs and assets. Below we outline a sample of the models we propose to consider (noting, too, that there exist permutations of each of these models, which would reflect the City's unique circumstances).

Open Model

In this model, the City builds fiber and wholly controls that asset. Private sector service provider(s) are selected to offer data services over it. In this model, the City's role is limited to building and maintaining the network. The open access model (also referred to as the "wholesale" or "passive layer" model) separates the infrastructure from the retail service.

In this model, the City is in the business of infrastructure, not communications service provision. In the open access model, the City's customer is not the retail consumer—rather, it is the service provider. By building an open infrastructure on which capacity is leased to private sector providers, the City would address the key barrier to market entry for potential retail providers—the cost of fiber infrastructure. The result is the potential for new competition-delivering, enhanced services.

City Utility

In this model, the City builds, owns, operates, and offers data services over the network. The City becomes a competitive provider of data services. (This is often referred to as an "over-build" model because the new provider builds new communications infrastructure "over" the wires and cables in areas where there are existing broadband systems.)

This model requires the City to finance the build-out of the network—and potentially to finance operations in the event that network revenues do not cover expenses. It also requires the City to define and update services on an ongoing basis, establish consumer-level sales and marketing efforts, and establish consumer-level help desk and other support mechanisms. The City utility model requires the broadest range of staff additions, training, marketing, and other activities to run and maintain the business venture.

City Partnering with a Private Entity (Public–Private Partnership)

Our analysis in this task will focus on the City’s reasonable expectations for developing a public–private partnership, the types of service options such a partnership might support, and the range of potential partnership arrangements the City might establish with private entities.

In general, in a public–private partnership model, the City engages private sector provider(s) to share ownership and operational responsibilities, and to offer services over the network. In this model, the City may choose varying levels of control and involvement, which will affect potential risk and reward. For example, the City might retain control of the fiber infrastructure, including network maintenance and expansion, or a chosen partner may propose to maintain the fiber network on behalf of the City.

We will look at the public–private partnership models evolving around the country, including variations (all of which are open to modification to suit the City and its partners). In one permutation, the City builds the fiber, while the private partner invests in network electronics and becomes the retail service provider. The private partner guarantees certain payments to the City for access to the fiber. This approach attempts to balance the risk, reward, and control between the public and private partners.

CTC is closely connected to current efforts by major cities, counties, and universities to enlist private sector partners for broadband services. Two of our clients have successfully signed partnership agreements for fiber network expansion and service delivery. For both of these public sector network owners, we helped with the identification, negotiation, and selection of partners. We have a strong sense of the types of partners to prioritize for potential discussions and the type of benefits that might accrue to the Madison community from a partnership.

Task 5: Prepare business model and financial analysis

Develop 10-year financial pro forma

As we have done for municipal broadband networks nationwide, we will develop 10-year pro forma data for the City’s broadband network operations. Based on the system-level design and cost estimates, the pro forma will illustrate the City’s funding requirements—and the impact of various assumptions and business models on the initiative’s long-term financial outcome.

Our business modeling will clearly identify both the City’s estimated return on investment (ROI) and the effects that self-funding or borrowing will have on the model. The pro formas will lead to clear guidance for the City in terms of required investment, estimated ROI, and risk factors.

This high-level financial model for the City’s proposed fiber construction will take into account a range of likely costs, including:

- Network implementation
- Network operations
- Network maintenance
- Funding / financing

Our base case model will reflect standalone City network operation; we will also analyze variations in three primary areas of network responsibility:

1. Fiber ownership and operation
2. Network electronics ownership and operation
3. Retail service provider operation and maintenance

By looking at the financial model holistically, the City will be able to more clearly identify the parameters of different partnership models, and better understand the risks and rewards from each party's perspectives.

We will outline operational attributes and processes including policies, staffing levels, maintenance agreements, and other considerations. We will pay particular attention to back-office and other operating requirements, maintenance requirements, and sustainability (including working capital projections).

The model will include an overall analysis of viable potential services and will provide:

- Sensitivities of key assumptions including, but not limited to:
 - o Customer segmentation (focused on commercial customers)
 - o Market penetration and take rates
 - o Pricing, including:
 - o Rate subsidies for low-income families
 - o Rates sufficient to ensure stability, sustainability, and ability to absorb contingency operating and capital expenses over time
 - o Tiered revenue structures
 - o Operating fees
 - o System construction
 - o Staffing levels
- Base, best, and worst-case analysis

The pro forma will follow accounting standards and will provide schedules that detail:

- Key assumptions
- Return on investment (ROI)

- Operating income and cash flow
- Net present value analysis
- Subscriber revenue by service
- Subscriber revenue by customer/customer class
- Debt service analysis
- Reserve fund requirements
- Uses and sources of funds
- Operating expenses
- Operational savings
- Depreciation summary
- Projected construction costs for network, hardware, buildings and other equipment

All of our assumptions and price sensitivities will be clearly stated and justified. This financial model will provide the City with an order-of-magnitude estimate of the overall project cost, and will support the implementation and funding roadmap by providing inputs for potential business models, funding options, and partnering opportunities.

Recommend public/private funding strategies and ownership models

Municipal broadband initiatives reflect both an ambitious vision and, often, a public commitment to financing broadband access for all citizens. Many municipalities have pursued grant funding, taken out bonds, or otherwise sought funding or financing for construction of publicly owned fiber networks.

Our goal in this task is to help the City develop realistic approaches to funding and operations. To our knowledge, for example, there are currently no federal grant funding opportunities for a city as urban as Madison. So our report will examine other viable options. And we will focus on demonstrating the business case as a means of working with the State, local organizations, or private partners under a range of these models.

We will draw on our hands-on knowledge of broadband funding opportunities (including E-rate and other federal funding programs, and state and regional programs), as well as our research capabilities in this area, to identify and compile a detailed list of potential funding opportunities for the City to consider. To the extent possible, we will “rank” these opportunities in terms of the likeliness that they will lead to successful funding.

Because we have worked for the public sector for almost three decades, we understand City budget and financing issues. Accordingly, we will analyze options for borrowing (including general obligation and revenue bonds) and provide a range of recommendations for financing structures.

As an example, we note that general obligation (GO) bonds are directly tied to the City's credit rating and ability to tax its citizens. This type of bond is *not* tied to any specific revenues from specific projects, but is connected instead to citywide taxes and revenues can be used to repay this debt. GO bonds are politically challenging because they require public approval, which can be hard won. Because of the politically polarizing nature of GO bonds, they are generally issued for projects that will clearly serve the needs of the entire community, such as roadway improvements. It is challenging in many communities to make the case for a fiber enterprise serving the public to such a degree that GO bonds are warranted.

In addition to analyzing specific financing structures, we will also discuss the feasibility of taking a phased approach to financing, which would spread the financial burden out over time, and thereby lessen the impact on the City and any other public financing sources. All of our evaluations will be conducted relative to the potential risks of a given strategy.

We will also assess ownership and governance models, such as standalone fiber optic enterprises, joint powers agencies, economic development corporations, or other potential structures.¹

Develop strategic approaches to incenting private investment

Building on the market and customer insight we develop in the previous tasks—and our nationwide experience in this field—we will develop strategies and plans for enabling the deployment of next-generation infrastructure in the City.²

Our analysis in this task will be driven by two sides of the infrastructure equation. On one side are the City's goals and objectives; on the other are the perceived barriers to investment for public or private sector partners. We will develop strategies that—while taking into account the current market and customer needs—will help the City achieve its goals while lowering those barriers.

For example, we will focus on how the City can incent private investment in fiber infrastructure. And we will explore ways in which the City can use its existing assets to spur private investment, as well as what modest investments the City could make to attract larger private investments over time.

¹ CTC is not qualified to provide legal advice. While we may identify regulatory or legal issues, we cannot provide legal guidance. We recommend that the City's legal counsel review and advise on all legal issues.

² We "wrote the book" on municipal fiber policies. CTC principals Joanne Hovis and Andrew Afflerbach, P.E. authored "Gigabit Communities," an independent white paper on municipal gigabit-facilitation strategies commissioned by Google. At the Fiber-to-the-Home Council conference in December, the head of Google Fiber's city selection team gave the keynote address; when she was asked in the Q-and-A session how Google Fiber developed its checklist for partnering with cities, she responded that Google just adapted CTC's work on the topic.

We will also develop strategic guidance on how to take advantage of any upcoming construction (whether by the City or a private entity) to enable the City to cost-effectively expand its infrastructure and meet its goals.

To the extent possible, we will examine incumbent or competitive service providers' stated plans to see where they are building. Even if we are not able to concretely determine where the companies are building, we will provide high-level strategic guidance on how to take advantage of future construction—potentially including recommendations regarding enacting citywide policies (e.g., to require construction of City conduit or fiber during underground construction by private carriers).

Task 6: Analyze requirements under State law and potential legal risks

Because CTC is not qualified to offer legal advice, we have included a highly qualified attorney on our team. For this task, Kenneth Fellman, Esq. of Kissinger & Fellman will undertake an examination of state laws (e.g., Wisconsin State Statute 66.0422) that may impact the various broadband network options identified for Madison. Mr. Fellman will also analyze potential legal risk related to a citywide FTTP network. In addition to identifying legal hurdles and risks, the legal analysis will suggest recommended strategies for pursuing the City's broadband goals. (We are also happy to work with another attorney of the City's choosing, and have itemized our pricing in Section 5 accordingly.)

Task 7: Compile and present comprehensive report

Our final deliverable will be a comprehensive written report, including a succinct executive summary, that presents our analysis of technical and business-model alternatives for deploying a citywide FTTP network in Madison. Our report will include a concise narrative supported by charts, tables, graphics, and maps. We will attribute and provide sourcing for our research.

We will provide the City's identified reviewers with an electronic draft of our report for initial review. We will incorporate the reviewers' feedback and edits within two weeks of receipt, and will deliver an electronic version of our final report.

We will also conduct an on-site presentation of the final report to the City. In addition to providing an overview of the project and our recommendations, we will be prepared to field audience questions and facilitate a discussion about the project and next steps.

2. Description of Project Team

We propose the following key team members—who will be supported, if the project schedule requires us to add resources, by our team of highly qualified staff analysts and engineers. Complete resumes for each staff member are attached in Appendix A below.

Joanne Hovis, CTC's President and Director of Business Consulting, will be the project manager and will lead all strategic and business planning tasks. An attorney who has provided network business model analysis and recommendations for some of the largest public broadband networks in the country, she is a recognized authority on the broadband market and community broadband topics—and on the evolving role of government in the provision of communications services to the public. Ms. Hovis has extensive experience developing business case and business model scenarios for public sector broadband initiatives. Ms. Hovis leads the CTC team that advises the states of New Mexico, Kentucky, Massachusetts, and Kansas, the cities of San Francisco, Seattle, and Washington, D.C., and the statewide broadband networks in Colorado, Maryland, and Pennsylvania.

Andrew Afflerbach, Ph.D., P.E., CTC's Director of Engineering, will oversee all technical research and analysis. Dr. Afflerbach has developed institutional networks for cities and counties, overseen the build-out of last-mile fiber networks, and works extensively on regional public safety networks. He is an experienced network planner who understands the business and financial implications of various network designs. He also leads the technical team conducting FirstNet planning for the District of Columbia. *Dr. Afflerbach, a CTC principal, has a degree in physics.*

Tom Asp, MBA, a Principal Engineer and Analyst, will lead all financial analysis tasks. He has more than 25 years of nationwide experience as an engineer and analyst in communications and public power systems. His experience includes telecommunication system design and evaluation of network feasibility. Mr. Asp has developed financial statements and prepared quantitative business plan analyses for municipal and utility clients nationwide. He also has extensive experience presenting to local and state government officials, conducting needs assessment interviews, and facilitating stakeholder sessions.

Kenneth Fellman, a Partner in Kissinger & Fellman, P.C., is an attorney who specializes in telecommunications and public utilities, administrative litigation, local government and employment law. He is past president of the National Association of Telecommunications Officers and Advisors, and has been representing local governments in communications and utility matters since 1985. With respect to municipal broadband networks, he represents the Colorado Communications and Utility Alliance, a statewide organization that advocates on behalf of local government broadband matters, among other things. He has also worked recently with the Cities

of Longmont, Montrose, Boulder, Centennial, Cortez and Glenwood Springs, Colorado, and Bozeman, Montana, on their broadband planning matters. Ken is also legal counsel to the EAGLE-Net Alliance, an intergovernmental entity that is the recipient of a federal broadband grant to build a statewide network to enhance broadband options for schools and libraries. He is currently working with consulting teams in three multi-jurisdictional regions in western Colorado on a variety of legal issues related to broadband planning and deployment.

Charlie Hamm, a *GIS Specialist and Staff Engineer*, will develop all necessary maps and data analysis. He has almost five years of professional experience in the broadband industry. He works with a range of geographic design programs—including AutoCAD, ESRI ArcGIS, Google Earth, Microsoft Streets and Trips, and Quantum GIS—to enable large-scale network design and construction projects, as well as to illustrate geographic data for feasibility studies. He creates databases and maps to support network route planning, utility pole attachment, and permit application processes.

Marc Schulhof, a *Principal Analyst and CTC's senior technical writer*, will write all project deliverables. He has more than 20 years of experience in technical writing, financial journalism, and public and corporate communications. Prior to joining CTC, Marc was the worldwide editor-in-chief of CIO program websites at IBM.

3. Description of Experience

About CTC

CTC is an established, woman-owned consulting firm that offers a unique combination of qualifications and capabilities in broadband financial analysis, business planning, engineering, and network strategic planning. Founded in 1983, we have extensive experience providing independent financial, strategic, and technical, guidance for public and non-profit communications networks, including those of state and local governments, non-profit consortia, universities, and municipal utilities.

CTC offers extensive experience and expertise in all aspects of feasibility studies, needs assessment, strategic and business planning, and network engineering. We have conducted similar assessments—including market surveys, business plans, engineering analyses, and financial pro formas—for public sector clients nationwide, including the cities of Palo Alto, San Francisco, Santa Cruz, and Seattle.

In Palo Alto, for example, CTC is developing both a fiber-to-the-premises (FTTP) master plan and a wireless network plan. In the FTTP engagement, we are working with the City's Information Technology and Utilities departments to research and prepare a strategic plan that outlines the feasibility of expanding the City's existing fiber system to provide citywide FTTP.

In Santa Cruz, CTC is performing a technical and financial feasibility analysis of multiple approaches to introducing FTTP and expanded middle-mile services in the City.

Many of our engagements have focused on low-risk public sector strategies to expand existing broadband infrastructure to promote economic development, enhance the availability of high-bandwidth services to local businesses, and increase broadband competition.

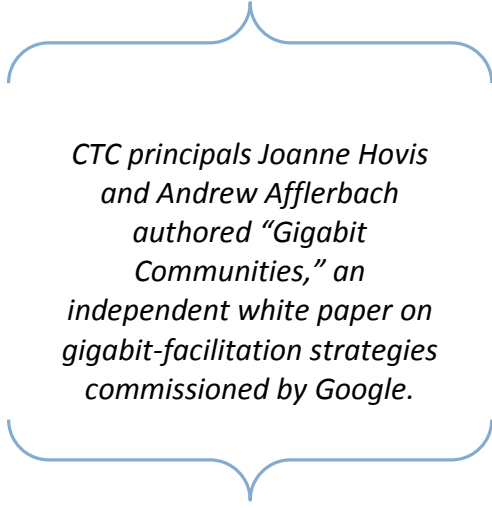
We specialize in helping clients develop phased approaches for implementing fiber networks to meet their needs; we are particularly experienced with helping communities to identify private partners for broadband communications initiatives. Our goal in these engagements is to develop relationships in which the private partner shares the risk of expanding a network to serve the community's broader needs. In these engagements, too, we



We are in an industry that is changing by the day with respect to regulatory frameworks, technology, and potential business models. What distinguishes CTC is that we are engaging those issues every day, developing new strategies for leveraging public and private sector investment to enable sustainable last-mile connectivity.

are vigilant about protecting the community's interests, and managing the community's risk with respect to partner financing and operations.

CTC is a highly respected firm with considerable experience and intellectual resources. Our reputation rests on our track record of providing independent, objective, and unbiased guidance. For more than three decades, we have served the public sector in evaluating its broadband deployment efforts and in bringing an independent, sometimes critical, eye to communications efforts.



CTC principals Joanne Hovis and Andrew Afflerbach authored "Gigabit Communities," an independent white paper on gigabit-facilitation strategies commissioned by Google.

CTC principals Joanne Hovis and Andrew Afflerbach authored "Gigabit Communities," an independent white paper on gigabit-facilitation strategies (www.Gigabit-Communities.com) commissioned by Google.³ Ms. Hovis and Dr. Afflerbach also co-authored, with the New America Foundation's Open Technology Institute, a report on local broadband networks: "The Art of the Possible: An Overview of Public Broadband Options."⁴ That study was recently cited in President Obama's report on municipal fiber networks, "Community-based Broadband Solutions: The Benefits Competition and Choice for Community Development and High Speed Internet Access."⁵

Ms. Hovis, Dr. Afflerbach, and other CTC staff have also authored guides on community fiber development for the Utilities Telecommunications Council, and the Tennessee Valley Public Power Association. These and other key documents are available in the library on our website.⁶

We have a robust roster of national and international clients, and our workload reflects that success. As we have proven over the past three decades, however, we are adept at managing our clients' needs and our staffing levels. We pride ourselves on our track record of completing projects on time, regardless of the size or complexity of the tasks at hand. We commit to providing an exceptional level of service and to meeting your timeline.

³ While this work was commissioned and supported by Google, CTC's analysis was entirely independent and focused on promoting city needs, rather than those of Google or any other network deployer. CTC and Google agreed contractually that CTC had complete editorial control over the content of the work. We are proud of our strong relationship with Google, but maintain independence as part of our mission to serve public sector clients.

⁴ <http://www.ctcnet.us/publications/the-art-of-possible-an-overview-of-public-broadband-options/>

⁵ http://www.whitehouse.gov/sites/default/files/docs/community-based_broadband_report_by_executive_office_of_the_president.pdf

⁶ www.CTCnet.us/library

Engaging with CTC means receiving customized analysis and the level of time, consideration, and care required to provide you with the answers you need. This level of service is complemented by our proven ability to communicate our findings and recommendations—in high-quality written reports and engaging in-person presentations—to decision-makers, elected officials, citizens, and other interested project stakeholders.

Representative Past Projects

As the examples below illustrate, we offer demonstrated experience and qualifications in the areas of network strategic planning, financial analysis, and business planning. These are just a few of the hundreds of client projects CTC has successfully completed over the past 32 years. Many additional examples are available on request.

City of Albuquerque, New Mexico: CTC developed a strategy for connecting the City's key stakeholders and locations with a network that will have the most impact on its economic development and digital inclusion goals. CTC surveyed candidate network routes and developed a system-level design and pricing estimates for the construction and operation of fiber infrastructure. Our strategic design maximized potential economic development, minimized budgeting risks, and positioned the City for future network expansion. CTC then prepared the technical portions of an RFP for the City's procurement process to identify an expert partner for the proposed fiber and wireless construction.

Arlington County, Virginia: CTC currently is designing and managing the construction of ConnectArlington, the last-mile fiber network that will connect approximately 80 of the County's government buildings, schools, and public safety facilities. CTC staff members, including an on-site project manager, are overseeing every aspect of the project, from network mapping to construction supervision and acceptance.

CTC has also developed the business plan and strategy for the County's dark fiber leasing initiative, and is currently preparing an RFP for the County's use in selecting a fiber broker. This third-party broker innovation is the first of its kind among public entities in the United States.

Additionally, CTC staff are providing critical input into the design and testing for other phases of the County's self-managed fiber construction project, which will ultimately have close to 60 miles of backbone fiber.

City of Atlanta: CTC currently is advising the City on strategic and tactical approaches it can take to plan, build, and operate its own fiber network to cost-effectively serve its internal needs, promote private sector broadband investment, and enable competition in the City's residential and business broadband markets. We are assisting the City in its discussions with Google Fiber

and other telecommunications providers about options for joint build and partnership, and providing technical due diligence for the City.

City of Boston: In an ongoing engagement, CTC is analyzing the City's strategic options for deploying fiber optics to connect public schools throughout the City. CTC's business analysts and engineers reviewed the engineering that the City had already completed; the stakeholders' previously identified needs and concerns; the extent of existing City infrastructure assets; and the general scope of the fiber network envisioned by the City. We are now exploring a wide range of public and public-private options for maximizing the benefits of the City's planned investment to get direct fiber connectivity to selected schools.

City of Culver City, California: CTC developed a high-level network strategy, design, and business model framework to support Culver City's planning of a fiber optic backbone and fiber optic connections to key economic development sites. The proposed strategy is designed to ensure that broadband infrastructure in Culver City evolves over time to meet the needs of its businesses, and public institutions.

Over the course of this project, CTC met with key city staff to review economic development objectives; reviewed the potential to leverage existing fiber and conduit assets in serving the city's identified target areas; facilitated discussions with business stakeholders and other community representatives to understand their perceptions regarding availability, reliability, and affordability of broadband services; researched the region's available services and costs; prepared a preliminary fiber network design to provide redundant connectivity in the city's target areas; developed a business model framework to guide the city's decision-making.

State of Delaware: CTC has provided communications engineering consulting services to the State Department of Transportation for almost 20 years. Most recently, our engineers and business analysts wrote the statewide master plan for deploying an integrated broadband fiber and microwave network.

District of Columbia: CTC performed a business case and technology analysis for DC-Net, a fiber optic telecommunications network that provides voice and data services for the District of Columbia government. The network consists of resilient, interconnected fiber optic rings that will eventually connect more than 400 government buildings in the District, including Police Department, Emergency Management Agency, and Fire Department radio towers.

CTC's independent assessment analyzed public safety, government, and educational uses of the network. The project tasks included asset mapping and network description; cost comparison to leased/managed services; functional and technical comparison between dark fiber and

alternatives; leveraging the ability to resell to other entities; identifying support mechanisms; and determining recommended business practices.

CTC serves in an ongoing role as strategic fiber advisor to the City, and is leading the technical team conducting FirstNet planning for the District.

EAGLE-Net: CTC reviewed the business plan and financial models of EAGLE-Net, an intergovernmental network organization serving more than 170 communities across Colorado. We analyzed the cost assumptions and projections, and proposed refinements as merited by economic changes in the service area and local market. We proposed a pricing structure for service to anchor tenants and suggested potential future network opportunities and appropriate strategies to capture additional users, both last-mile providers and anchor institutions. We prepared marketing and sales plans designed to realize revenues necessary to sustain the EAGLE-Net enterprise in the future.

CTC recently completed a statewide project with the Commonwealth of Kentucky in which we provided consulting and planning services in support of the governor's proposed statewide, next-generation fiber optic network. The Commonwealth announced a \$250 million to \$350 million concessionaire agreement with a private sector partner in December.


Town of Holly Springs, North Carolina: CTC conducted a broadband needs assessment and developed a strategic approach and return on investment (ROI) analysis for the town's proposed fiber network implementation. Our team of project managers, outside plant engineers, and network engineers then designed and oversaw implementation of a middle-mile fiber network serving the town's community anchor institutions (e.g., schools and libraries) and major economic development partners. The first sites on the 19-mile network went live in June 2014.

Kansas Statewide Broadband Initiative: CTC supported the Kansas Statewide Broadband Initiative (KSBI), a program of the Kansas Department of Commerce, in a major analysis of broadband availability and usage across the state. The scope of work included a broadband needs assessment of schools, libraries, and hospitals, completed in 2013, and two additional reports on the broadband market in the residential and commercial sectors. All three reports were delivered to the state legislature.


Commonwealth of Kentucky: CTC recently completed a statewide project with the Commonwealth of Kentucky in which we provided consulting and planning services in support of the governor's proposed statewide, next-generation fiber optic network.

CTC engineers performed a technical assessment of the state’s current network plans, developed a strategy for fiber construction, and provided detailed guidance on network operations. Our business analysts assessed the state’s current network financial models, refined projections, and collaborated on the development of a sustainable governance and business model.

CTC also developed an RFI to identify potential fiber collaborators for the Commonwealth. The RFI attracted responses from more than a dozen candidates—including service providers, technology companies, equity partners, and concessionaires—and made it possible for the CTC team to refine the Commonwealth’s business model and develop an RFP that more closely fit the business model and the firms’ capabilities. The Commonwealth announced a \$250 million to \$350 million concessionaire agreement with a private sector partner in December.



CTC developed a reference architecture and technical guidelines for the New Zealand government’s nationwide open access Ultra-Fast Broadband initiative.



Keystone Initiative for Network Based Education and Research (KINBER): CTC provided KINBER, a statewide fiber optic network in Pennsylvania and recipient of a \$99.6 million federal grant, with extensive support in developing their business model and pricing schedule. Our team conducted interviews with KINBER project stakeholders to assess the statewide market for networking services. We combined this information with our existing, in-depth knowledge of public sector networking initiatives, markets, and pricing schedules. We then presented different business model scenarios based on varying take rates of the networking services offered. We gave preliminary marketing advice and conducted initial outreach on behalf of KINBER to potential new members. CTC also prepared engineering advice for how to cost-effectively provide networking services.

City of Lawrence, Kansas: CTC evaluated the state of broadband in Lawrence and proposed strategies for expanding network infrastructure to serve homes, businesses, and the public sector. In our project report, “Enhancing Broadband in Lawrence: A Range of Strategic Options,” we identified ways in which Lawrence can maximize its current assets to encourage future technology development. It analyzes the existing communications environment in Lawrence and provides recommendations with respect to various options to leverage the City’s existing fiber optic infrastructure. (That report is available on our website: <http://www.ctcnet.us/wp-content/uploads/2014/01/LawrenceBroadbandReport.pdf>.) Following up on that engagement,

we also recently evaluated issues and concerns for the City's consideration as it evaluates whether to require open access on privately funded fiber in the City.

Maryland Inter-County Broadband Network (ICBN): CTC was the lead engineer for the development of the ICBN project, a \$72 million sub-grantee of the One Maryland Broadband Network (see below). We designed and engineered ICBN fiber routes for four large counties. In addition, a CTC Principal Engineer served as Portfolio Manager for the project across nine counties. He was the lead technical consultant overseeing the grant funds to build 800 miles of fiber optics and connect approximately 650 community anchor institutions.

Commonwealth of Massachusetts: CTC President Joanne Hovis advises the Massachusetts Technology Cooperative on a wide range of broadband issues, including last-mile network deployment, business planning, and managing statewide stakeholder relationships.

National Capital Region (NCR) Interoperability Program: CTC provided the concept, engineering design, and project management for the National Capital Region Interconnection Network—a 120-mile public safety network interconnecting 19 fiber-optic based government networks in the greater Washington, D.C. region. This network was conceived as a backbone for interoperable communications that could take advantage of existing fiber infrastructures the governments already controlled.

State of New Mexico: CTC wrote a guidebook for New Mexico's local governments to lead them through the business, financial, and strategic planning necessary to implement city- or county-owned broadband networks. We are currently engaged in developing a statewide strategic plan for deployment and adoption of broadband in the State, as well as in preparation of regional implementation plans.

State of New York: CTC currently is designing New York State's public-private partnership model—a key element in Governor Cuomo's \$500 million "Broadband for All" initiative, which aims to deliver 100 Mbps services to every home and business in the state.

Government of New Zealand (Crown Fibre Holdings): CTC developed a reference architecture and technical guidelines for the New Zealand government's open access Ultra-Fast Broadband initiative. The project included establishing requirements for vendors bidding on the design, construction, and operation of a planned nationwide fiber network that will connect at least 75 percent of the country's population.

One Maryland Broadband Network (OMBN): Working closely with the Maryland Department of Information Technology (DoIT), CTC provided strategic guidance and was the lead engineering and business planning consultant in conjunction with the development of OMBN's successful \$115 million federal grant application. Our services included network architecture, plant

engineering, and detailed project preparation, with a focus on expanding the state's existing fiber optic network to reach underserved areas and achieve other program goals. CTC also provided extensive business planning, business modeling, and pro forma preparation.

City of Palo Alto: In two current, parallel projects, CTC is developing both a fiber-to-the-premises (FTTP) master plan and a wireless network plan for the City of Palo Alto. In the FTTP engagement, we are working with the City's Information Technology and Utilities departments to research and prepare a strategic plan that outlines the feasibility of expanding the City's existing fiber system to provide citywide FTTP. In the wireless engagement, we are conducting a system-level requirements analysis and a needs assessment, and recommending wireless technologies, network designs, and business models.

CTC previously provided strategic guidance and advice to the City of Palo Alto on expanding its dark fiber network to create opportunities for enhanced municipal and commercial services. We assessed how to leverage existing infrastructure to promote commercial wireless broadband deployment and improve municipal Smart Grid and public safety technologies. We also prepared a framework for how to establish a public-private partnership to encourage greater wireline infrastructure construction.

City of Raleigh: CTC recently completed a project with the City of Raleigh to develop a roadmap for meeting the city's future networking needs. CTC engineers performed a technical assessment of the city's network plans, developed a strategy for fiber construction, and providing detailed guidance on middle-mile network operations. Our business analysts assessed the city's current network financial models, refined those projections, and created a sustainable business model that will enable the city to capitalize on excess fiber to create revenue and other community benefits. CTC also supported the city on the completion of its Google Fiber Checklist.

City and County of San Francisco: CTC currently is developing technical specifications for a municipal "dig once" policy to facilitate the cost-effective expansion of broadband infrastructure throughout the city.

We previously prepared a series of path-breaking analyses of the feasibility of the City building and operating a fiber-to-the-premises (FTTP) network—including a system design and detailed analysis of candidate architectures and open access models. The project also included analysis of multiple business models and business recommendations customized for San Francisco's unique circumstances.

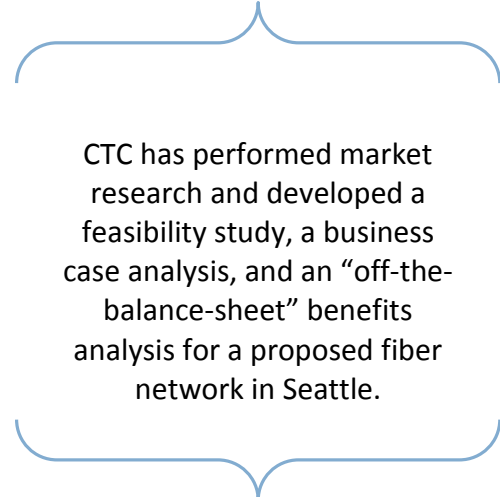
CTC also provided ongoing consulting and strategic guidance with respect to an FTTP pilot and related technology projects, and helped the City with business planning, financial analysis, and engineering design to support its preparation of an extensive application for federal grant

funding. The market research analysis provided measurements to predict emission reductions and other ancillary benefits of facilitating work-at-home initiatives through an FTTP implementation.

Schools, Health and Libraries Broadband (SHLB)

Coalition—To support SHLB’s filing with the FCC in the matter of E-rate modernization, CTC developed a methodology, conducted engineering and geographic analysis, and prepared a nationwide assessment of the cost to construct fiber to every unserved school and library in the country.⁷ Chairman Wheeler specifically

mentioned to our client the importance of our model in the FCC’s E-rate analysis, and the model was cited in the FCC’s just-released report on E-rate modernization.⁸



CTC has performed market research and developed a feasibility study, a business case analysis, and an “off-the-balance-sheet” benefits analysis for a proposed fiber network in Seattle.

City of Seattle / Seattle City Light: CTC currently is supporting the city with business, technical, and strategic guidance as it explores options for FTTP network deployment in light of the changing national marketplace and emergence of new business models.

This engagements follows on multiple significant projects we have completed with the city and its electric utility over the past six years. CTC has previously performed market research and developed a feasibility study, a business case analysis, and an “off-the-balance-sheet” benefits analysis for a proposed fiber network.

The first study, “FTTP Municipal Broadband Risks and Benefits Evaluation,” included an internal needs analysis, market research of both residential and business customers; an assessment of competing services and technologies; and an evaluation of the business case and business risks.

Following on that report, CTC researched and wrote an “FTTP Benefits Evaluation,” which explored the benefits of FTTP beyond the traditional balance sheet, including cost avoidance, monetary savings, and environmental impact. Notably, this report was one of the first of its kind to qualify and quantify (where possible) community-wide benefits of ubiquitous broadband connectivity such as enabling increased telecommuting, reductions in greenhouse gas emissions, and positive impacts on vulnerable populations such as the elderly and low-income residents.

⁷ <http://www.ctcnet.us/news/shlb-submits-ctc-study-to-fcc/>

⁸ "In the Matter of Modernizing the E-rate Program for Schools and Libraries," WC Docket No. 13-184, Second Report and Order and Order on Reconsideration, FCC 14-189, adopted December 11, 2014, at 44.

In the third phase of this project, CTC advised the Mayor of Seattle regarding the U.S. communications market and business planning strategies for a citywide fiber enterprise. CTC led and facilitated a business planning working group comprised of the Mayor’s senior staff, the directors of the city’s electric and water/sewer utilities, and the city’s Chief Technology Officer.

Cities of Urbana and Champaign / University of Illinois: CTC has been the strategic and business planning consultant to Urbana, Champaign, and the University of Illinois for more than five years—since the coalition first conceived of constructing a middle-mile fiber network to connect community anchor institutions. We prepared the network’s successful federal Environmental Assessment, which enabled construction to begin. Following construction of the federally funded middle-mile project, we wrote a request for information (RFI) to enable the cities and the university to identify a private partner that would finance and operate an FTTx expansion of the network to serve 100 percent of the community. We evaluated potential partners’ proposals, then helped to negotiate with two partners to reduce the community’s risks and ensure that a partnership will achieve the coalition’s policy goals for economic development and digital inclusion.

As a result of the coalition’s final partnership—which Telecompetitor has called “a particularly good deal for the community”⁹—UC2B has secured an open access Gigabit FTTx network buildout that will protect its public policy interest by providing the same opportunity for access to the entire community. In return, UC2B’s partner—the ISP and network operator iTV3—gets value through access to UC2B’s existing middle-mile infrastructure (which it will operate) and the foundation of a significant last-mile consumer network.

Commenting on the partnership, FCC Chairman Wheeler said that it “provides a valuable model for communities and companies throughout the country and a demonstration of the creativity that is stimulated when localities are free to work with the private sector to improve broadband offerings.”¹⁰

City of Vallejo, California: CTC recently was awarded a contract by the City to develop a fiber optic master plan to guide the feasibility, long-term planning, budgeting and implementation of a municipal broadband network. In our technical analysis and planning, we will conduct a detailed investigation of the City’s existing conduit. And in our business planning tasks, we will focus on serving commercial customers—and on a model that will be self-funding over time.

⁹ <http://www.telecompetitor.com/urbana-champaign-gigabit-network-will-open-access/>

¹⁰ <http://www.fcc.gov/document/fcc-chairman-tom-wheeler-stmt-uc2b-and-itv-3-gigabit-announcement>

City of Westminster, Maryland: CTC prepared a fiber feasibility study and business case for the City of Westminster in 2012 and 2013. Our report, which focused on maximizing available backbone network connectivity, included a technical design and cost estimates for two last-mile FTTP pilot projects (one focused on residential customers, one focused on businesses).

Following the city's decision to move forward with the pilot projects, CTC is currently providing support on a range of fiber infrastructure engineering, network design, construction oversight, and quality assurance tasks.

We also assisted the city in identifying a private partner to assume operating risk in providing services to the public over the city's FTTP infrastructure; the city announced its public-private partnership in mid-January. For more details, see CTC's website:

<http://www.ctcnet.us/blog/maryland-city-announces-groundbreaking-fiber-partnership-with-internet/>.

4. References

We invite you to contact the following references about the quality, independence, and timeliness of CTC's work. Many additional references are available on request.

City of Palo Alto, California

Mr. Jim Fleming
Management Specialist
(650) 566-4586, Jim.Fleming@CityofPaloAlto.org

City and County of San Francisco

Mr. Brian Roberts
Senior Policy Analyst, Department of Telecommunications & Information Services
(415) 581-4061, brian.roberts@sfgov.org

City of Culver City, California

Ms. Michele Williams
Chief Information Officer
(310) 253-5950, Michele.williams@culvercity.org

Seattle City Light

Ms. Carol Butler
Director, Corporate Performance Division, Seattle City Light
(206) 615-1249, carol.butler@seattle.gov

City of Seattle

Mr. Tony Perez
Director, Office of Cable Communications
(206) 386-0070, Tony.Perez@Seattle.gov

5. Cost

CTC proposes to perform the tasks identified in the scope of work above for a not-to-exceed cost of \$97,000, broken down as follows. *We will not charge for any travel or expenses.*

Tasks 1 -5 and Task 7: \$80,000

Task 6 (Legal Analysis): \$17,000

If the City chooses instead to contract directly with an attorney for legal analysis—whether Ken Fellman, who we include on this proposal, or another attorney of its choosing—we would be happy to work with the attorney in parallel to our evaluation of business, financial, operational, and political risk. (We note that if the City does contract directly with an attorney, it would preserve attorney-client privilege.)

We are available to provide additional as-needed, ongoing support to the City; we will bill any mutually agreed upon additional work at the hourly rates listed below.

Because our clients are almost exclusively in the public sector, our rates are extremely competitive relative to many consultants who do business planning, engineering, and other kinds of strategic work on communications projects.

Labor Category	Rate
Director of Business Consulting / Engineering	\$170
Principal Analyst / Engineer	\$160
Senior Project Analyst / Engineer	\$150
Senior Analyst / Engineer	\$140
Staff Analyst / Engineer	\$130
Communications / Engineer Aide	\$ 75

As standard procedure, CTC bills monthly and requires payment within 30 days. CTC’s billing rates are inclusive of all routine expenses including administrative, accounting, and computer support, telephone calls, and photocopying.

Appendix A: Staff Resumes

Joanne S. Hovis, Esq. | President and Director of Business Consulting

Joanne Hovis is President of CTC. She is an attorney and business planner with a two-decade background in communications and broadband. Ms. Hovis is a recognized authority on the broadband market and community broadband topics—and on the evolving role of government in the provision of communications services to the public.

Ms. Hovis leads the CTC team that advises the states of New Mexico and Kansas; the cities of San Francisco, Washington, D.C., and Seattle; the American Recovery and Reinvestment Act (ARRA) funded UC2B (Champaign and Urbana, Illinois) and ICBN (central Maryland) networks; and the statewide broadband networks in Colorado, Maryland, and Pennsylvania. She advises the University of Illinois, Case Western Reserve University, and a number of other institutions regarding broadband planning.

Ms. Hovis also oversees all ongoing CTC research and analysis for local government clients and frequently provides business planning and analysis for communications networking initiatives such as San Francisco's planned fiber network and the public safety communications network currently under development in the Washington, D.C. metropolitan area. She also leads CTC's consulting on the federal E-Rate and Healthcare Connect Fund programs.

Ms. Hovis serves as Immediate Past President of the National Association of Telecommunications Officers and Advisors (NATOA), which represents local governments and promotes community interests in communications matters. She is a member of the boards of directors of the Benton Foundation and OneCommunity, and is a charter member of the United States Unified Community Anchor Network (U.S. UCAN) project's Task Force on Community Anchor Network Economic Models. She is also CEO of the Coalition for Local Internet Choice (CLIC).

Ms. Hovis previously worked as an attorney with Jenner & Block in Chicago and Mintz, Levin, Cohn, Ferris, Glovsky, & Popeo PC in Washington, D.C. At those firms, she worked on complex communications and litigation projects for such clients as Salomon Brothers and AOL.

Business Planning and Feasibility Analysis

Ms. Hovis leads all of CTC's business planning efforts. She has spearheaded projects that explore a range of business models by which government clients can leverage their existing assets to build, expand, and incentivize broadband expansion. She is sought nationwide as an expert in municipal ownership and operational broadband business models, fiber and wireless markets, and public-private partnerships. Among the projects she has led are:

- **City of Seattle.** Ms. Hovis advised the Mayor of Seattle regarding the U.S. communications market and business planning strategies for a citywide enterprise. She reported the public subsidies a network would require, and delivered a full assessment of opportunities and

risks. The report included internal needs analysis, statistically significant market research, an assessment of competing services and technologies, and an evaluation of the business case and financial risks. Ms. Hovis led further analysis of the benefits of FTTP beyond the traditional balance sheet, including cost avoidance, monetary savings, and environmental impact. She led and facilitated a business planning working group comprised of the Mayor's senior staff, the directors of the city's two utilities (electric and water/sewer), and the city's CIO.

- Ms. Hovis advises the **State of New Mexico's Department of Information Technology** on broadband planning. She led a team of writers and analysts that produced a guidebook for New Mexico's local governments to guide them through the business, financial, and strategic planning necessary to implement city- or county-owned broadband networks. The book-length guidebook offers specific instructions for localities to research and document the telecommunications infrastructure in their communities, and discusses strategies for exploring public-private partnerships for broadband expansion.
- Ms. Hovis is working with the **State of Kansas Department of Commerce** on a large-scale needs assessment of the state's network infrastructure. She is conducting major market surveys among three core sectors across the state (residents, businesses, and community anchor institutions) to evaluate the current uses and needs of broadband infrastructure. She is also developing a strategy for the evolution of Kan-ed, the state-created broadband program that serves schools, hospitals, libraries, and higher education institutions.
- Ms. Hovis has advised officials in the **District of Columbia** government on a range of telecommunications and fiber-optic projects for almost a decade. She worked with the Office of the Chief Technology Officer (OCTO) to create a business plan and strategy for building a municipal fiber-optic network with a wireless overlay in the least-served wards of the city. She performed a business case and technology analysis (including five-year projections) for DC-Net, a fiber-optic telecommunications network that provides voice and data services for the District of Columbia. She analyzed governmental, educational, and public safety uses of the network. The project tasks included asset mapping and network description; developing a cost comparison to leased/managed services; identifying opportunities to resell to other entities; identifying support mechanisms; and determining recommended business practices. She performs an ongoing role as strategic fiber adviser to the Chief Technology Officer and the Director of DC-Net, and supports planning for the network's future—including expanding the network to a broader array of end users.
- Ms. Hovis advises the **Urbana-Champaign Big Broadband (UC2B) Coalition (University of Illinois and the cities of Champaign and Urbana)** on a wide range of business and strategic planning issues. She is currently evaluating the private sector bids to build out last-mile fiber connections in the cities. She took a leading role in preparing UC2B's successful application for a federal Broadband Technology Opportunities Program (BTOP) stimulus grant to support its proposed FTTP network.
- Ms. Hovis provided extensive business planning, market assessment, and strategic planning for the **City and County of San Francisco**. Ms. Hovis served as a key adviser to the city's Chief Information Officer. She conducted an independent evaluation of the

feasibility of San Francisco constructing and operating a municipal FTTP network to serve businesses and residences. As a first step toward the FTTP network, she worked with the City to plan a migration of the leased telecommunications services connecting 250 government facilities to a City middle-mile fiber-optic network; she also supported the city's application for BTOP funding. She reviewed cost and pricing factors associated with using leased telecommunications services and circuits provided by private vendors, as compared with migration to government-owned fiber optics. She projected the return on investment and total cost of ownership (including a wide range of costs from deployment to staffing to maintenance to financing to cutover expenses). She evaluated potential efficiencies to be realized through in-house rather than outsourced provision of services and circuits.

- Ms. Hovis led a feasibility study of the **City of Ocala, Florida's** fiber-optic enterprise. She explored the potential range of business models and services that the city could implement to leverage its existing fiber-optic network and staff skill sets. She performed a competitive assessment of existing private sector broadband services and conducted market research with statistically significant surveys of the local commercial and residential sectors to assess current and future demand for high-speed connectivity. She proposed logical expansion strategies derived from in-depth analysis of financial costs, business models, and potential benefits to the community of multiple options.
- Ms. Hovis performed an expert assessment of the business and marketing plan for Utah's inter-jurisdictional network, **UTOPIA**. She led a strategy session with key stakeholders, collected relevant background material, performed an analysis of UTOPIA market research and marketing models, and independently evaluated UTOPIA's business plan. At the direction of UTOPIA leadership, her work focused on improving the participating UTOPIA communities' ongoing cash flow.
- Ms. Hovis devised a business strategy and wrote a business plan for **KINBER**, the BTOP-funded statewide backbone and middle-mile fiber infrastructure focused on the higher education and healthcare sectors in Pennsylvania. One highlight of the KINBER strategy was developing an actionable plan to increase early cash flow.
- Ms. Hovis developed a broadband feasibility study for **Garrett County, Maryland** with a specific focus on maximizing the benefits and use of the fiber backbone being built by the BTOP-funded One Maryland Broadband Network (OMBN) project.

Grant Planning & Management

Ms. Hovis' expertise includes the many funding opportunities available to local government broadband planners through the federal government and other sources. She has guided clients through the grant process, from application writing to fund management.

Ms. Hovis' grant work has included:

- Supporting more than a dozen clients in securing American Recovery and Reinvestment Act (ARRA) funds through the Broadband Technology Opportunities Program (BTOP). Successful applicants included including the \$22.5 million Urbana-Champaign Big Broadband (UC2B) project, the \$115 million One Maryland Broadband Network (OMBN),

the \$32.1 million OpenCape project in Cape Cod, and Washington, D.C.'s \$17.5 million Community Access Network (DC-CAN).

- Securing additional National Telecommunications & Information Administration (NTIA) funds from the **Public Safety Interoperable Communications (PSIC)** grant program on behalf of public health and public safety communications projects in the National Capital Region (NCR), encompassing Washington, D.C. and almost two-dozen surrounding jurisdictions.
- Developing a successful application to the **Appalachian Regional Commission (ARC)**—a partnership among federal, state, and local government—for Garrett County, Maryland.
- Providing business case development and ongoing business planning support to significant **Urban Areas Security Initiative (UASI)** grant-funded projects in the NCR.
- Advising a number of clients on **Rural Utilities Service (RUS)** grant applications, and reviewing business plans and projections that make use of RUS loan funds for entities such as UTOPIA, the regional non-profit open access fiber network in suburban and rural Utah.

Speaking and Advocacy

Ms. Hovis is in wide demand as a speaker and expert source on broadband deployment issues. She has testified before the U.S. Congress on matters of broadband deployment and policy; has been interviewed by publications including *Business Week*, the *Washington Post*, and the *Baltimore Sun*; and has been featured on the C-SPAN show “The Communicators.”

She has provided expert presentations to the Federal Communications Commission, National League of Cities, Technology Policy Summit, the University of Illinois, Case Western Reserve University, the New America Foundation, and the Congressional Internet Caucus.

Ms. Hovis recently authored “Gigabit Communities: Technical Strategies for Facilitating Public or Private Broadband Construction in Your Community”—an independent report sponsored by Google and intended as a guide for local government leaders and planners.

EDUCATION

Juris Doctor, with honors, University of Chicago Law School, 1994

- Patino Fellow, awarded for academic achievement and community service, 1991–94

Bachelor of Arts, with distinction, University of Wisconsin, Madison, 1990

- General Distinction and Distinction in the Major, 1990
- Dean’s List, 1988–1990
- Weinstein Award, 1990
- Hebrew University of Jerusalem, Davis Institute for International Studies, 1989

PROFESSIONAL CERTIFICATIONS/LICENSES

Member of Illinois Bar Association, Member of District of Columbia Bar Association

ORGANIZATIONS

- Coalition for Local Internet Choice, CEO
- National Association of Telecommunications Officers and Advisors, Immediate Past President
- Benton Foundation, Director
- OneCommunity, Director
- United States Unified Community Anchor Network, Task Force on Community Anchor Network Economic Models, Charter Member

PRIOR TO COMING TO CTC IN 1997

1996–1997 Litigation/Communications Attorney, Mintz, Levin, Cohn, Ferris, Glovsky, & Popeo P.C., Washington, D.C.

1994–1996 Litigation Attorney, Jenner & Block, Chicago

Andrew Afflerbach, Ph.D., P.E. | CEO and Director of Engineering

Dr. Andrew Afflerbach specializes in planning, design, and implementation of communications infrastructure and networks. His expertise includes emerging fiber and wireless technologies and state-of-the-art networking applications.

As Director of Engineering, he oversees all engineering work performed by CTC Technology & Energy. He is a licensed Professional Engineer in the Commonwealth of Virginia and the states of Delaware, Maryland, and Illinois.

Dr. Afflerbach has planned and overseen implementation of a wide variety of government and public safety networks, including the infrastructure of state and metropolitan area governments. He prepared extensive technical analyses for submission to the Federal Communications Commission (FCC) and policymakers on national fiber expansion to underserved schools and libraries, on due diligence for the IP transition of the telecommunications infrastructure, and on potential technical frameworks for wireless network neutrality. He also recently served as a senior adviser to Crown Fibre Holdings, the public entity that is directing New Zealand's national fiber-to-the-home project.

Broadband Planning and Engineering

Dr. Afflerbach has architected, designed, and overseen implementation of numerous broadband networks for local and state governments, including those of Washington, D.C.; Crown Fibre Holdings (Government of New Zealand); San Francisco; the Commonwealth of Kentucky; the Delaware Department of Transportation; the Maryland Transportation Authority; St. Louis Park, Minnesota; and many large counties.

Advisory Services

Dr. Afflerbach advises a wide range of policy think tanks, U.S. federal agencies, and non-profits regarding the engineering issues underlying key communications issues. For example, he:

- Leads the technical team conducting FirstNet planning for the District of Columbia (Washington, D.C.).
- Serves as key technical advisor to the Commonwealth of Kentucky as it deploys its statewide Next Generation Kentucky Information Network.
- Provided expert testimony to the U.S. Federal Communications Commission (FCC) in the matter of the preparation of the national broadband plan as a representative of the National Association of Counties (NACo) and the National Association of Telecommunications Officers & Advisors (NATOA).
- Served as expert advisor regarding broadband deployment to the U.S. Conference of Mayors, NACo, National League of Cities, and NATOA in those organizations' filings before the FCC in the matter of determination of the deployment of a national, interoperable wireless network in the 700 MHz spectrum.
- In connection with the FCC's ongoing Open Internet proceeding, advised the New America

Foundation regarding the technical pathways by which “any device” and “any application” regimes could be achieved in the wireless broadband arena as they have been in the wireline area.

- Provided expert technical advice on the 700 MHz broadband and AWS-3 proceedings at the FCC for the Public Interest Spectrum Coalition (including Free Press, the New America Foundation, Consumers Union, and the Media Access Project).
- Prepared technical reports and analysis regarding fiber construction for submittal to the FCC, in connection with preparation of the National Broadband Plan, by NATOA, the City and County of San Francisco, and the Schools, Health, and Libraries Coalition.
- Served as technical advisor to the Naval Exchange in its evaluation of vendors’ broadband communications services on U.S. Navy bases worldwide.
- Advised the U.S. Internal Revenue Service regarding the history of broadband and cable deployment and related technical issues in that agency’s evaluation of appropriate regulations for those industries.
- Advised, during the height of the broadband “open access” debate, a variety of public interest associations and communities, including the City of Los Angeles and Stanford University, regarding the technical means by which cable networks could be opened to competition.
- Advised the Stanford Law School Center for Internet and Society on the technical issues for their briefs in the *Brand X* Supreme Court appeal regarding cable broadband.
- Provided technical advice to numerous non-profits, associations, and agencies as diverse as the Center for Internet and Society at Stanford Law School; the Internal Revenue Service, the Alliance for Community Media, the William Penn Foundation, the Center for Digital Democracy, and the FCC’s Local and State Government Advisory Board (LSGAC).
- Has been invited to speak about communications technologies before such organizations as the Public Technology Institute, American Association of Community Colleges, ICMA, ILCMA, and the Practicing Law Institute.
- Developed curricula for a variety of organizations, including the University of Maryland, the United States Department of Transportation, and the George Washington University.
- Has taught courses and delivered seminars regarding communications for numerous educational and government institutions.

Public Safety Network Interoperability and Interconnection

Dr. Afflerbach served as lead engineer and technical architect for planning and development of NCRnet, a regional fiber-optic and microwave network that links public safety and emergency support users throughout the 19 jurisdictions of the National Capital Region (Washington, D.C. and surrounding jurisdictions), under a grant from the U.S. Department for Homeland Security’s Urban Areas Safety Initiative. He wrote the initial feasibility studies that led to this project for regional network interconnection.

Smart Grid

Dr. Afflerbach and the CTC team provided expert testimony and advisory services to the Public

Service Commission of Maryland regarding Advanced Metering Infrastructure (AMI). CTC provided objective guidance to the staff as it evaluated AMI applications submitted by three of the state's investor-owned utilities (IOUs). This contract represented the first time the PSC staff had asked a consultant to advise them on technology—a reflection of the lack of standards in the Smart Grid arena, and the magnitude of the investment that the utilities were proposing.

Instruction/Expertise

Dr. Afflerbach has served as an instructor for the U.S. Federal Highway Association/National Highway Institute, the George Washington University Continuing Education Program, the University of Maryland Instructional TV Program, ITS America, Law Seminars International, and the COMNET Exposition.

He teaches and helped develop an online graduate-level course for the University of Maryland. He developed and taught communications courses and curricula for ITS America, COMNET, and University of Maryland. His analysis of cable open access is used in the curriculum of the International Training Program on Utility Regulation and Strategy at the University of Florida.

Dr. Afflerbach has also prepared client tutorials and presented papers on emerging telecommunications technology to the National Fire Protection Association (NFPA), NATOA, the National League of Cities (NLC), the International City/County Management Association (ICMA), and the American Association of Community Colleges (AACC). He also taught college-level astrophysics at the University of Wisconsin.

EMPLOYMENT HISTORY

1995–Present	CEO/Director of Engineering, CTC Previous positions at CTC: Principal Engineer, Senior Scientist
1990–1996	Astronomer/Instructor/Researcher University of Wisconsin–Madison, NASA, and Swarthmore College

EDUCATION

Ph.D., Astronomy, University of Wisconsin–Madison, 1996

Master of Science, Astronomy, University of Wisconsin–Madison, 1993

Bachelor of Arts, Physics, Swarthmore College, 1991

PROFESSIONAL CERTIFICATIONS/LICENSES

Professional Engineer, Commonwealth of Virginia and states of Delaware, Maryland, and Illinois

HONORS/ORGANIZATIONS

- Association of Public-Safety Communications Officials (APCO)
- Board of Visitors, University of Wisconsin Department of Astronomy
- National Association of Telecommunications Officers and Advisors (NATOA) Technology and Public Safety Committees
- Armed Forces Communications and Electronics Association (AFCEA)
- Society of Cable and Telecommunications Engineers (SCTE)

- Institute of Electrical and Electronic Engineers (IEEE)
- Charleston Defense Contractors Association (CDCA)
- NASA Graduate Fellow, 1993–1996. Research fellowship in astrophysics
- Elected Member, Sigma Xi Scientific Research Honor Society
- Eugene M. Lang Scholar, 1987–1991, Swarthmore College

SELECTED PUBLICATIONS, PRESENTATIONS, and COURSES

- “Mobile Broadband Networks Can Manage Congestion While Abiding By Open Internet Principles,” prepared for the New America Foundation’s Open Technology Institute – Wireless Future Project, November 2014.
- “The State of the Art and Evolution of Cable Television and Broadband Technology,” prepared for Public Knowledge, November 2014.
- “A Model for Understanding the Cost to Connect Schools and Libraries with Fiber Optics,” prepared for the Schools, Health & Libraries Broadband Coalition, October 2014.
- “The Art of the Possible: An Overview of Public Broadband Options,” prepared jointly with the New America Foundation’s Open Technology Institute, May 2014.
- “Understanding Broadband Performance Factors,” with Tom Asp, Broadband Communities magazine, March/April 2014.
- “A Brief Assessment of Engineering Issues Related to Trial Testing for IP Transition,” prepared for Public Knowledge and sent to the FCC as part of its proceedings on Advancing Technology Transitions While Protecting Network Values, January 2014
- “Gigabit Communities: Technical Strategies for Facilitating Public or Private Broadband Construction in Your Community,” prepared as a guide for local government leaders and planners (sponsored by Google), January 2014
- “Critical Partners in Data Driven Science: Homeland Security and Public Safety,” submitted to the *Workshop on Advanced Regional & State Networks (ARNs): Envisioning the Future as Critical Partners in Data-Driven Science*, Internet2 workshop chaired by Mark Johnson, CTO of MCNC, Washington, D.C., April 2013
- “Connected Communities: How a City Can Plan and Implement Public Safety & Public Wireless,” submitted to the International Wireless Communications Exposition, Las Vegas, Nevada, March 2013
- “Cost Estimate for Building Fiber Optics to Key Anchor Institutions,” prepared for submittal to the FCC by the National Association of Telecommunications Officers and Advisors and the Schools, Health, and Libraries Coalition, September 2009.
- “Efficiencies Available Through Simultaneous Construction and Co-location of Communications Conduit and Fiber,” prepared for submittal to the FCC by the National Association of Telecommunications Officers and Advisors and the City and County of San Francisco, 2009, referenced in the National Broadband Plan.
- “How the National Capital Region Built a 21st Century Regional Communications Network” and “Why City and County Communications are at Risk,” invited presentation at the FCC’s National Broadband Plan workshop, August 25, 2009.
- “Existing and Emerging Broadband Technologies,” NATOA Conference, October 2007.

- “An Assessment of the Technical Capabilities of the AWS-3 Spectrum,” expert report prepared for Free Press, December 2007.
- “An Engineering Assessment of Select Technical Issues Raised in the 700 MHz Proceeding,” expert report prepared for FCC filing for Free Press and Media Access Project (Public Interest Spectrum Coalition), May 2007.
- “Understanding FiOS and U-Verse Architecture,” presented at NATOA’s Policy and Legal Conference, Washington, D.C., spring 2007.
- “Fiber to the Premises and Fiber to the Node,” *Journal of Municipal Telecommunications Policy*, Fall 2006.
- “Communications Infrastructure Primer,” presented to the National Fire Protection Association, Miami Beach, FL, 2006.
- Supplemental Report, “Technological Analysis of Open Access and Cable Systems,” <http://www.aclu.org/Privacy/Privacy.cfm?ID=17507>, prepared for American Civil Liberties Union and Stanford Law School Center for Internet and Society, 2005.
- *Affordable Telecommunication Networks for Local Government*, International City/County Management Association, November 2004.
- “Telecommunications and ITS: What You Need To Know,” prepared curriculum for two-day training course for the University of Maryland, 2001.
- “Technological Analysis of Open Access and Cable Systems,” prepared for ACLU, 2001.
- “No Pipes: Wireless Broadband,” *Journal of Municipal Telecommunications Policy*, 2001.
- “Interactive PEG: Technical Strategy for Implementation,” *Community Media Review*, 2000.
- “Telecommunications and Intelligent Transportation Services,” two-day training course, presented in multiple cities for the US Department of Transportation/ITS America, 1999.
- “Building Integrated Voice, Data, and Video Networks for the Local and Wide Area,” two-day training course, presented for the University of Maryland, 1999.
- “Integrated Data, Video & Voice Broadband Networks,” week-long training course, presented at the COMNET Exposition, Washington, DC, and January, 1999.
- “LANs: Design and Installation of Networks that Support Voice, Data, and Video Applications,” multi-day training course, presented for the George Washington University Continuing Engineering Education Program, 1996; 1997; 1998; 1999.
- *Cable Network Technology: A Primer for Local Officials*, International City/County Management Association, September 1998.
- “I-Nets and the Internet,” Infotech Report, August 1998.
- “Integrated Data, Video & Voice Broadband Networks” and “Design & Implementation of Metropolitan Area Networks (MANs),” presented at the 1998 COMNET Exposition.

Thomas J. Asp, BSEE, MBA | Principal Engineer and Analyst

Mr. Asp specializes in evaluating connectivity (voice, video, and data) options and recommending effective solutions for clients throughout the United States. He holds more than 25 years of experience as an engineer and analyst in communications and public power systems. His experience includes electric and telecommunication system design, network feasibility, evaluation of the financial impact of projects on operations, and provision of expert testimony.

Mr. Asp is recognized as an expert in evaluating and offering recommendations regarding municipal broadband communications systems. He has been actively involved with telecommunication market research and feasibility analysis for over a decade, both with CTC and previously as a partner at the public accounting firm of Virchow Krause (Baker Tilley). Mr. Asp also has significant experience in the communications industry working in the areas of cellular, cable TV, broadband, and mobile radio, including as a product manager in the Cellular Mobile Telephone, Automatic Meter Reading, and Distribution Automation industries.

Broadband Networks (Wired and Wireless)

Mr. Asp is regarded as one of the premiere analysts in the United States regarding municipal planning and deployment of broadband systems to meet economic development, digital inclusion, and other needs. He has assisted numerous local governments, municipal utilities, and municipal consortia to evaluate their communities' communications needs and determine the financial parameters and business case for meeting those needs.

In this area, Mr. Asp's experience includes preparing connectivity feasibility studies for municipal networks, including economic analysis, market assessment, technology review, vendor analysis, and business plan development. He has assisted numerous communities with evaluating the feasibility of advanced connectivity services alternatives including provider partnerships and city-owned networks. He has reviewed options under cable franchise agreement for municipal purchase and operation. Mr. Asp has reviewed offerings and operations of incumbent telecommunications providers and assisted in negotiations with incumbent telecommunications providers to enhance availability of existing services and to encourage new and innovative offerings.

Some select examples of his projects include:

- Provided Jackson (Tennessee) Energy Authority an independent evaluation of responses to JEA's 2010 request for proposals (RFP) soliciting vendors to provide wholesale voice services. With JEA staff input, he developed the evaluation system and scoring matrix to ensure a balanced approach that best met JEA's needs. Responses were evaluated on the basis of strategic fit, operational fit, reliability, and overall cost; recommended two respondents as finalists for further consideration by JEA; and assisted JEA in negotiating with those finalists. As a final step in the process, CTC presented to JEA management a written report recommending the "best-fit" vendor.

- Completed a business and technology plan for Los Angeles Department of Water and Power (LADWP) to determine the feasibility of expanding the connectivity services offered to the businesses and institutions over the Department's fiber network. Included in the analysis was a valuation of additional fiber routes that LADWP acquired from the City of Los Angeles.
- Developed a business plan for the Commonwealth of Kentucky's Next Generation Kentucky Information Highway. The plan identified strategies for deploying a sustainable network, potential pricing for lit and dark services, and the impact of grants and variations in construction costs.
- Served as a business consultant to the City and County of San Francisco. Investigated the feasibility of the city building and operating a fiber-to-the-premises (FTTP) network to every home and business in San Francisco. The project included an analysis of multiple business models and business recommendations customized for San Francisco's unique circumstances.
- Developed a business case analysis for DC-Net, a District-owned and operated fiber optic telecommunications network that provides voice and data services. The network consists of resilient, interconnected fiber optic rings that connect more than 400 government buildings in the District, including Police Department, Emergency Management Agency, and Fire Department radio towers.
- Conducted a feasibility study, a business case analysis, and an "off-the-balance-sheet" benefits analysis for a fiber-optic network proposed by the mayor of the City of Seattle. The first study, FTTP Municipal Broadband Risks and Benefits Evaluation, sponsored by Seattle City Light, included the following elements:
 - Internal needs analysis
 - Market research of both residential and business
 - Assessment of competing services and technologies
 - Evaluation of the business case and business risks

Following on that report, Mr. Asp researched and wrote an FTTP Benefits Evaluation for the City, which explored the benefits of FTTP beyond the traditional balance sheet, including cost avoidance, monetary savings, and environmental impact.

- Performed an expert assessment of a business and marketing plan for Utah Telecommunication Open Infrastructure Agencies (UTOPIA's) open access FTTP network. The project included a strategy session with key stakeholders, collection of relevant background material, an analysis of UTOPIA market research and marketing models, and an independent evaluation of UTOPIA's business plan. Mr. Asp's work focused on improving the participating UTOPIA communities' ongoing cash flow and increasing participation of households and businesses in those communities.
- Prepared a fiber optic business plan for Richland Utilities, Washington to meet the needs of city facilities, the electric utility, schools, hospitals, banks, and other institutions. Work included preparation of various business models, review of operational requirements, and preparation of pro-forma financial statements.
- Provided extensive business planning assistance to the State of Maryland's One Maryland program, which lead to build an interconnected fiber-optic broadband network that

reaches every county and city in Maryland and will provide backbone and middle-mile capacity for commercial carriers.

- Managed project assisting Bountiful City, UT with the development of a business plan for a citywide wireless network. This project included the review of a conceptual design, reviewing proposed business relationships and staffing, and conducting a cost-benefit analysis.
- Project manager in assisting Ames, IA with the review of existing architecture, development of a network design, and preparation of detailed cost estimates for the acquisition and installation of WiFi hot spots and supporting infrastructure. This project has now moved into implementation preparations.
- Led consulting team in investigating several WiFi deployment models, development of a business plan (including market research and financial analysis), and development of a partnership RFP for St. Louis Park, MN. Mr. Asp assisted the city to pilot the network and then prepared specifications and bid documents to identify both integrators and operators for the network.
- Assisted the City of Tucson, AZ with a wireless feasibility study that included market research, competitive industry assessment, internal and external needs assessments, financial analysis, and the development of a business plan.
- Assistance in the implementation of an Institutional Fiber Network (I-Net) for Norwich Public Utilities in Norwich, CT. Project included development of a plan and strategy for the Fiber Optic Enterprise.

DA, AMR, SCADA

In the areas of Distribution Automation (DA), Supervisory Control and Data Acquisition (SCADA), mobile radio, and Advanced Metering Infrastructure (AMI), Mr. Asp has assisted municipal utilities and public power cooperatives with extensive evaluative and design services. Specifically, he has prepared evaluations and submitted recommendations on AMI alternatives and benefits. He has assessed existing and evolving technologies and services to support AMI and DA for electric utilities and has developed and directed demonstration plans to test technologies to support distribution automation -- including providing recommendations for establishing vendor alliances, performing research and designs networks to combine multi-utility communications, and outlining, evaluating, and recommending communication requirements and options for electric utility DA, SCADA, mobile radio, and AMI.

TESTIMONY & VALUATION

In addition to assisting over 80 communities and counties in evaluating financial opportunities to provide voice, data, and video services, Mr. Asp has provided financial and technical testimony and expert advice. Some examples include:

- Conducted an exhaustive business case analysis and prepared expert witness testimony on behalf of the City of Alameda in a federal court case involving the business practices, business results, and ultimate sale of its fiber optic enterprise. The testimony included a

comparative analysis of business models employed by municipal fiber networks nationwide and a review and valuation of several recent cable business transactions.

- Maryland Public Service Commission regarding Baltimore Gas & Electric's application for deployment of AMI and smart grid technologies. Written and sworn testimony included an analysis of smart grid technologies, vendor development, and impact to rates.
- Pacific Gas & Electric regarding the financial and technical viability of the use of Broadband over Power line (BPL) for Automatic Meter Reading (AMR) and support of new business opportunities. Mr. Asp prepared a report in anticipation of being called to testify before the California PUC
- The City of Lebanon, OH in connection with a dispute over an Assessment of Infrastructure Connectivity Fee with home-builders and Time Warner Cable. The Assessment and disposition regarded the reasonableness of the connection fee assessed to each new home by the municipal telecom department
- The City of Marshal, MO in determination of the value of the incumbent cable television system owned and operated by Time Warner.

EDUCATION

Bachelor of Science, Electrical Engineering, North Dakota State University, 1979

Master of Business Administration, University of St. Thomas, St. Paul, 1989

Charlie Hamm | GIS Specialist and Staff Engineer

Charlie Hamm works with a range of geographic design programs—including AutoCAD, ESRI ArcGIS, Google Earth, Microsoft Streets and Trips, and Quantum GIS—to enable large-scale network design and construction projects, as well as to illustrate geographic data for feasibility studies. He creates databases and maps to support network route planning, utility pole attachment, and permit application processes.

EXPERIENCE

Columbia Telecommunications Corporation, GIS Specialist/Staff Engineer, 2011 – present

Charlie researches, aggregates, and manipulates data to create maps essential to projects. His specific client engagements have included the following:

Prince George's County, Maryland

- Created GIS shapefiles to document the locations of cellular antennas within the county

Inter-County Broadband Network (ICBN)

Provided GIS map management and design for the ICBN, a sub-grantee of the State of Maryland's federally funded One Maryland Broadband Network (OMBN):

- Used Visio to generate splice matrices for the contractors connecting fibers in Prince George's, Montgomery, and Anne Arundel counties
- Created GIS maps based on data developed during the update to the project's Environmental Assessment
- Developed overview maps of the ICBN build for project managers
- For a related fiber-to-the-premises (FTTP) project in a portion of Anne Arundel County:
 - Entered field notes into GIS
 - Generated bills of materials (BOMs)
 - Applied for environmental, county, and state permits
 - Used Visio to generate splice matrices for contractors

Garrett County, Maryland

- Analyzed data on availability of broadband service to identify unserved areas
- Created shapefiles in ESRI ArcGIS for incorporation into the county's GIS database

Arlington County, Virginia

- Assist county and CTC engineers in creating system-level drawings of last-mile engineering for ConnectArlington, the county's municipal fiber network
- Oversee incorporation of countywide fiber optic design into county's GIS database

Carroll County, Maryland and Spotsylvania County, Virginia

- Analyzed residential cable service to determine compliance with the counties' franchise agreements and develop strategies for franchise renewal negotiations
- Converted Bentley data into GIS format for analysis of broadband service

National Capital Region Interoperability Program

- Create and update as-built documentation for the NCRnet fiber network in Visio
- Provide ongoing mapping support for expansion of NCRnet
- Acted as primary point of contact for the construction contractor that built a grant-funded Maryland Department of IT fiber link connecting two sites

Northern Illinois University (NIU)

- Geocoded survey results to generate GIS maps

U.S. Postal Service (USPS)

- Searched the National Broadband Map database to identify and analyze data related to broadband connectivity near postal facilities nationwide
- Manipulated CSV files for multiple states to create maps of broadband service availability based on the FCC's definition of underserved areas

Anne Arundel County, Maryland

- Performed OTDR and power meter testing for fiber acceptance

James Madison University, Research Assistant, 2010

- Created a GIS map of student enrollment for the campus

Virginia Department of Game and Inland Fisheries, Extern, 2009

- Measured and recorded fish data

EDUCATION

James Madison University

B.S., Geographic Science, 2011

- Dual concentration in Applied Geographic Information Science (AGIS) and Environmental Concentration, Sustainability and Development (ECSD)

ESRI Training Courses

- Learning ArcGIS Desktop, 2010
- Creating and Maintaining Metadata Using ArcGIS Desktop, 2010
- Cartographic Design Using ArcGIS 9, 2009

Software Skills

- AutoCAD, ESRI ArcGIS, Google Earth, GPS Pathfinder Office
- Microsoft Streets and Trips, Quantum GIS, Remote sensing software

Marc Schulhof | Senior Analyst and Technical Writer

Marc Schulhof has more than 20 years of experience in technical writing, financial journalism, and public and corporate communications. Marc's excellent editorial skills and his extensive experience with analyzing IT and business topics have enabled him to play an integral role in supporting a range of research and writing projects, including:

- Master plans (business and engineering)
- Needs assessments
- Feasibility studies
- Survey instruments
- Expert witness testimony
- Federal grant applications
- Requests for proposal
- Cellular tower siting reports
- Letters, press releases, and website content

Prior to joining CTC, Marc was the worldwide editor-in-chief of CIO program websites at IBM, where he established editorial direction for 36 country-specific CIO websites and worked with local editors to update each site's mix of multimedia content. He also wrote and edited feature articles and white papers on information technology and business topics.

Marc's experience also includes his role as a global editor at PricewaterhouseCoopers Consulting, where he wrote and edited reports on a variety of technology and business topics, and served as editor of the PwC-sponsored *BusinessWeek Online Handheld Edition* daily news summary for mobile device users. As an associate editor at *Kiplinger's Personal Finance Magazine*, he researched, analyzed, and wrote about a range of complex financial issues.

EDUCATION

Bachelor of Science, Journalism, Northwestern University

Master of Science, Journalism, Northwestern University

Kenneth S. Fellman | Partner, Kissinger & Fellman, P.C.

Birthplace and Date: Queens, New York; April 1956

Education: 1981 – Juris Doctor, University of Denver College of Law
1978 – Bachelor of Arts, Johns Hopkins University

Bar Admissions: Colorado; U.S. District Court District of Colorado; Tenth Circuit Court of Appeals; Sixth Circuit Court of Appeals; United States Supreme Court

Employment History:

1984 – Present Kissinger and Fellman, P.C., Denver, Colorado
Partner (since 1989) specializing in telecommunications and public utilities, administrative litigation, local government and employment law.
University of Colorado School of Law, Boulder, Colorado

2010 – Present
Adjunct Faculty, Telecommunications Law and Policy

1982 – 1984 Sole Practitioner, Idaho Springs, Colorado
General civil and commercial practice.

1981 – 1982 Levine & Pitler, P.C., Denver, Colorado
Associate emphasizing civil litigation and real estate law.

Areas of Concentration: Telecommunications law and policy development, local government law, cable television and public utilities franchising, local government/community broadband networks, right of way management, utilities regulation, administrative litigation, and business law. Serves as General counsel for the Colorado Communications and Utility Alliance, and the Colorado Government Association of Information Technology.

Publications: Social Media After 10 Years: Free Speech and Employee Use of Social Media Sites in 2014, *New Jersey League of Municipalities Magazine*, March 2014 (with Nancy C. Rodgers); FCC Rulemaking Impacts Local Land Use Authority, *New Jersey League of Municipalities Magazine*, December 2013; Franchising 2010, *Broadband and Cable Industry Law 2010*, Practising Law Institute, January 2010 (with Nicholas P. Miller); Zoning Ordinances for Wireless

Communications Facilities, published in NATOA's *Local Government Officials e-Guide to Communications Facilities Siting*, May 2009; *Broadband in Colorado: Why it Matters to Municipalities*, *Colorado Municipalities*, April 2009 (with Joanne Hovis); Highlights from the NATOA Policy and Legal Seminar, *NATOA Journal of Municipal Telecommunications Policy*, Summer 2008 (with Nancy Cornish Rodgers); A Baseball Fan's Assessment of the Federal Telecommunications Legislation Game, *NATOA Journal of Municipal Telecommunications Policy*, Winter 2006; Emerging Telecommunications Legislation: The Challenging Road Ahead, *NATOA Journal of Municipal Telecommunications Policy*, Winter 2005 (with Brett Chardavoyne).

Other Activities:

Mayor, City of Arvada, 1999-2007; City Council member-at large, 1993-1999; frequent speaker with state, regional and national groups on broadband network deployment, municipal franchising and telecommunications law issues; Member, Federal Communications Commission Intergovernmental Advisory Committee, 2011-present; Member, Governor's Innovation Council and Broadband Task Force, 2007-2013; Member, Colorado Channel Authority (currently serving as vice-chair), 2009-present; Chair, Board of Directors, Arvada Center for the Arts and Humanities, 2014; PeaceJam, Annual Fundraising Luncheon co-chair, 2009-10; Member, Lutheran Medical Center Foundation Board of Directors, 2009-present; Member, Arvada Charter Review Committee, 2011; Co-chair, Arvada Community Food Bank capital campaign, 2008-2009; Metro Denver Health and Wellness Commission, 2005 – 2010; Member, Arvada Fire Protection District Blue Ribbon Committee, 2010; Chairman, Local and State Government Advisory Committee to Federal Communications Commission, 1997-2003; Executive Committee, SAFECOM, 2004-2005; Chairman, Colorado Municipal League Telecommunications Committee, 1995-2000; Member, Colorado Municipal League Utilities Committee, 2003-2011; National League of Cities, Information, Technology and Communications Steering Committee, 1997-2007 (Chair 2005); U.S. Conference of Mayors, Transportation and Communications Committee, 2002-2007; Advisory Board, University of Colorado Interdisciplinary

Telecommunications Program, 2003-present; Metro Mayors Caucus, Chair, 2002-2003; Board of Directors, Northwest Metro Chamber of Commerce, 1992-1993; City of Arvada Planning Commission, 1988-1993, Chairman 1991-1993.

Professional Associations:

President, National Association of Telecommunications Officers and Advisors 2009-2013 (President, Colorado Chapter, 1995-1998); Colorado Bar Association; Continental Divide Bar Association (Past President); Metro City Attorney's Association (President, 1996-1997); International Municipal Lawyers Association; First Judicial District Bar Association; Phi Alpha Delta Law Fraternity.

Awards:

2007, 2010-2014 Law & Politics' Colorado Super Lawyers, a list representing the top 5% of Colorado attorneys; 2014 Top Lawyer in Communications, Technology and Media Law, 5280 Magazine; 2013 Law Week Colorado Barrister's Best Government Lawyer; 2011, Finalist, Law Week Colorado's Lawyer of the Decade; 2011 Arvada Chamber of Commerce Pioneer Award; 2010 Law Week Colorado's Information and Innovation Lawyer of the Year; 2007 Public Health Champion awarded by the Jefferson County Department of Health and Environment; 2006 National Association of Telecommunications Officers and Advisors, President's Special Recognition Award; 1998 Member of the Year; 2006 Outstanding Contribution Award – Metro City Attorneys Association; 2005 Award for Legislative Excellence from Colorado Public Health Association; 2004 named one of the 100 most influential citizens in the history of the City of Arvada during City's Centennial celebration.

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