ctc technology & energy

engineering & business consulting

April 26, 2016

Mr. Todd Slatin
Purchasing Director
Lexington-Fayette Urban County Government
Room 338, Government Center
200 East Main Street
Lexington, KY 40507

Subject: RFP# 13-2016 – Information Technology Consulting and Technical Services

Dear Mr. Slatin:

Columbia Telecommunications Corporation (d/b/a CTC Technology & Energy) (CTC) is pleased to provide this proposal in response to the Lexington-Fayette Urban County Government's (LFUCG) RFP.

CTC is a woman-owned engineering and technology firm that assists local and state governments, higher education institutions, and non-profit entities nationwide. We have more than 30 years of experience providing consulting and engineering services to clients across the United States and Canada. We are proud of our successful past engagements with the LFUCG and the Commonwealth of Kentucky.

Please feel free to contact me with any questions about our proposal or our company. We look forward to the opportunity to continue supporting the LFUCG.

Sincerely,

Joanne S. Hovis

Joanne S. Hovis | President

Columbia Telecommunications Corporation

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1. Vendor Requirements

In the sections that follow, we describe the CTC services that align with LFUCG's requirements.

Technology Assessment

CTC does not offer this type of services. Our completed Attachment A is attached below.

Support Services

CTC does not offer this type of services.

Software Development

CTC does not offer this type of services.

Consulting

CTC offers demonstrated experience and qualifications in providing these consulting services required by the LFUCG:

- Technical Requirements Gathering
- IT Strategic Planning
- IT Governance
- IT Project Management
- Certified Project Management (PMP)
- Network Technologies

Approach and Methodology

CTC's approach to meeting the LFUCG's requirements would closely follow the approach we have taken with the LFUCG in previous engagements,[1] and that we take with our public sector clients nationwide. As a general statement, we are guided by regular communications and priority-setting. The CTC Program Manager and staff assigned to the engagement would capture the LFUCG's requirements both through the Work Request/Statement of Work process, and through regular interaction with the LFUCG's point of contact and staff.

In addition to managing long-term assignments, CTC staff assigned to an LFUCG task would determine the costs, logistics, and other components needed to address specific project needs as they arise. Staff would also determine other stakeholders to include in the planning, as well as additional resources that would be necessary from the LFUCG, CTC, and potentially other parties.

Then, in coordination with the LFUCG's project manager, the CTC staff would prepare a timeline, a benefits analysis, and an assessment of potential risks. Upon approval to proceed, the CTC staff would then deploy and coordinate resources, oversee the project progress, provide regular

[1] Our previous work for the LFUCG has been as a subcontractor to Solarity.

reports to the LFUCG's project manager or designated point of contact, and conduct or oversee testing and verification as needed.

Experience

We pride ourselves on having met our public sector clients' consulting needs in a variety of IT functional areas over the past three decades. CTC has supported hundreds of public sector clients on IT, technical, strategic, and business-planning engagements. In addition to fiber and wireless engineering, we are experts in financial analysis (including cost-benefit and financial feasibility studies for communications initiatives), large-scale strategic planning, needs assessment, and public safety communications.

We focus on cost-effectively solving our clients' technical needs and developing solutions that deliver long-term strategic benefits and ensure that public sector IT investments create the greatest possible value.

We currently are engaged in projects on behalf of the cities of Louisville and Pikeville, Kentucky, as well as for the State of Ohio's economic development partner on broadband planning (JobsOhio), and for the states of Connecticut, Delaware, and New Mexico.

CTC's engineers and analysts offer the experience and analytical agility to engage virtually any strategic, technical, or business issue regarding communications infrastructure. We are responsible for high-profile initiatives for innovative clients:

- We are the "go-to" firm nationally for addressing big-picture strategic issues such as creating a robust, secure communications fiber infrastructure for regional public safety coordination and response in the National Capital Region (NCRnet).
- We advised the White House and the FCC to focus broadband stimulus on middle-mile fiber optics and community anchor institutions rather than obsolete DSL technology.

We are recognized for our thought leadership on community broadband issues:

- 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.[2]
- Ms. Hovis also recently authored "The Emerging World of Broadband Public–Private Partnerships: A Business Strategy and Legal Guide" (published by the Benton Foundation).[3]
- Ms. Hovis and Dr. Afflerbach co-authored, with the New America Foundation's Open Technology Institute, a report on local broadband networks: "The Art of the Possible: An

[2] 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.

[3] https://www.benton.org/sites/default/files/partnerships.pdf

Overview of Public Broadband Options."[4] That study was cited in President Obama's report, "Community-based Broadband Solutions: The Benefits Competition and Choice for Community Development and High Speed Internet Access."[5]

CTC's record of performance with public sector clients on IT consulting and technical services engagements spans a wide range of assignments and skill sets.

And we have established credentials in hands-on IT engagements. For example, in Montgomery County, Maryland—a jurisdiction bordering Washington, D.C., with one million residents and a mix of urban, suburban, and rural communities—we built the County's technical operations center (TOC) as both a point to monitor the system and as a central point of handoff to the cable operators. We specified the equipment, wrote the requests for proposal (RFP), installed the equipment, and integrated the TOC with the network.

In addition to our experience supporting local and state governments with tactical decision-making, we also bring to bear our high-level policy expertise. For example, CTC's Director of Engineering, Andrew Afflerbach, Ph.D., P.E., served as technical adviser to the Chief Technology Officer of Crown Fibre Holdings, the entity overseeing the construction of a $1 billion fiber optic network to 75 percent of all homes and businesses in New Zealand.

For ease of review, we have listed sample client experience in the following categories:

- Large-scale strategic planning and financial analysis engagements
- Telecommunications engineering consulting engagements
- Wireless communications engineering support engagements

Many additional examples are available on request.

Large-Scale Strategic Planning and Infrastructure Engagements

Commonwealth of Kentucky: CTC supported the Commonwealth with technical, business planning, and strategic policy guidance on Governor Steven Beshear's proposed next-generation fiber network. Our advisory work led to the Commonwealth's signing a $250 to $350 million concessionaire agreement with a private partner, Macquarie Capital, in late 2014.

In the first stages of our ongoing engagement, CTC engineers developed a strategy for fiber construction and provided detailed guidance on network operations. Our business analysts assessed the Commonwealth's current network financial models, refined projections, and collaborated on the development of a sustainable governance and business model.

[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

CTC then developed an RFI to identify potential fiber collaborators. The RFI attracted responses from a dozen candidates—including service providers, technology companies, equity partners, and concessionaires—and made it possible for CTC to refine the Commonwealth's business model and develop an RFP that more closely fit the business model and the firms' capabilities.

Following the announcement of the Commonwealth's concessionaire agreement—which, to our knowledge, is the largest public–private fiber-optic communications partnership of its type in the U.S.—CTC is providing ongoing support of the Commonwealth's technical, business planning, and strategic needs.

For example, CTC provided specifications and assistance in vendor selection for a Next Generation 9-1-1 pilot. And CTC is assisting the City of Pikeville, Kentucky in determining how best to connect to the network for economic development and government services.

State of Delaware: CTC has provided IT and strategic planning consulting services to the State's Department of Transportation (DelDOT) for 15 years. We wrote the master plan for deploying an integrated statewide broadband fiber and microwave network. That project included an evaluation of DelDOT's existing use of technology and communications networks, and detailed recommendations for a technology strategy and hardware implementations.

Fairfax County (Virginia) Public Schools: CTC worked with key FCPS stakeholders to perform a comprehensive technology evaluation and develop a Digital Media Management Strategy that maps the future state of technology in the school system. CTC surveyed existing technical systems and outlined FCPS's current technical infrastructure and business processes, including system-level technical schematics; flow-charts for existing business processes; inventories of hardware, software, and services; and narrative descriptions of each of these elements. Our report identified cost savings and recommended hardware, software, and process-oriented changes.

New Mexico Public School Facilities Authority: CTC researched the existing broadband infrastructure choices at each of the 800 public schools in the State of New Mexico and developed capital and operating cost models for upgrading the schools' existing broadband connections. Our report to the State legislature analyzed the technical, economic, operational, and financial considerations of a full range of strategies.

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 network to reach underserved areas and achieve other program goals. CTC also provided extensive business planning, business modeling, and pro forma preparation.

City of Rockville, Maryland: CTC prepared a comprehensive IT disaster recovery plan to guide the City's response in the event of a loss of critical IT capabilities. The plan categorized risks to IT

systems; prioritized IT systems based on their criticality; provided recommendations regarding IT system architecture and configurations to mitigate the risk of a disaster; defined the policies and procedures by which personnel respond to a disaster; provided guidelines pertaining to staff training, testing, and plan updates; and provided detailed plan implementation materials specific to the IT assets, including a recovery procedure template and key contact information.

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 "UC2B" 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 network, we wrote a request for information to enable the cities and the university to identify a private partner that would finance and operate an FTTP expansion. We evaluated potential partners' proposals, then helped to negotiate to reduce the community's risks and ensure that the partnership would achieve policy goals for economic development and digital inclusion.

As a result of the coalition's final partnership—which *Telecompetitor* called "a particularly good deal for the community"[6]—UC2B secured an open access Gigabit FTTP network buildout. UC2B's partner 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."[7]

City of Westminster, Maryland: As the City's long-time broadband adviser, CTC has played a key role in planning the City's FTTP network and negotiating the innovative public–private partnership that will enable a private partner, Ting, to build the last mile. The risk-sharing agreement we helped to design and negotiate is the first of its kind in the country—and will likely become the model for future public–private partnerships nationwide. (For more details on the City's partnership, see CTC's website: http://goo.gl/aI4Sau.)

Our current engagement with the City began with our preparation of a fiber feasibility study and business case in 2012. Our report, which focused on maximizing 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). CTC designed and provided quality assurance oversight and acceptance testing for the 10-mile pilot project that the City later constructed. CTC currently is developing detailed OSP network designs for the entire Citywide FTTP deployment.

[6] http://www.telecompetitor.com/urbana-champaign-gigabit-network-will-open-access/
[7] http://www.fcc.gov/document/fcc-chairman-tom-wheeler-stmt-uc2b-and-itv-3-gigabit-announcement

Telecommunication Engineering Consulting Engagements

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.

Anne Arundel County, Maryland: CTC currently is completing a large-scale outside plant (OSP) fiber design and engineering effort—under budget and ahead of schedule. Our work supports a County-funded project to connect more than 100 community anchor locations and extend County-built fiber infrastructure. CTC's engineering team is providing the construction plans; splicing designs; environmental analysis and permitting; County and state permitting; and acceptance testing for approximately 90 miles of OSP construction. CTC has supported the County on the development of its fiber network and other networking resources for more than a decade.

Arlington County, Virginia: CTC currently is designing and aiding in the management of 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 are overseeing every aspect of the project, including:

- Preparing a scope of work (SOW) for the project construction
- Network mapping, field surveys, and walkouts
- CAD documentation and GIS mapping
- Permitting and pole attachments
- Cost estimating and development of construction RFP
- Construction supervision and acceptance

CTC also recently completed a high-level business plan and strategy for leasing dark fiber to support economic development.

These engagements continue CTC's longstanding support of the County. We have worked with County officials since the mid-1990s on a range of projects, including negotiation of the original I-Net as part of the cable franchise renewal with Cable-TV Arlington, and developing telecommunication strategies and enhancing network route diversity and survivability for the I-Net. As part of the survivability plan we developed, we performed a detailed evaluation of the County's fiber routes, including the network hub buildings, switches, physical infrastructure, routing, and points of failure. We described potential approaches to reducing points of failure and outlined an evolutionary path to a new County-deployed fiber architecture.

We also developed a strategic telecommunications plan for the County, which included evaluating the fiber network, the processes involved with managing and operating applications on the network, and the coordination among agencies using the network. We designed a roadmap for evolving from a cable-company-operated network to a publicly owned and operated model.

City of Bowie, Maryland: CTC developed a comprehensive IT and network solution to support the relocation of the City's network operations center (NOC). CTC specified network equipment, audited and remediated network switch, firewall, and server configurations, and performed a detailed security assessment. CTC currently is in the process of developing a strategic roadmap for the upgrade of the City's network and continued virtualization of the City's datacenter over the coming years.

District of Columbia: CTC is the technical and business planning adviser to the District in its planning for the FirstNet national wireless public safety broadband network, and is the technical lead in the District's FirstNet State and Local Implementation Grant Program. Among our tasks are a comprehensive assessment of the wireless communications needs of all District public safety departments and agencies.

In a separate engagement, CTC designed a neutral-host distributed antenna system (DAS) network to enable the District to use its citywide fiber to distribute wireless signals. CTC then worked with the District to develop a program for installing commercial, public safety, and Wi-Fi wireless systems in its key facilities. This $10 million, five-year program will improve wireless communications in as many as 60 city-owned buildings.

Additionally, CTC assisted the District in developing a strategy for the use of small-cell technology, in which cellular carriers use poles and rooftops owned by the District to increase the density of their high-speed 4G LTE networks and deliver better service. We helped the District move to the forefront of cellular deployment technology by developing a plan for standardizing equipment and space utilization for hundreds of proposed tower sites. Our plan will allow the District to maximize profits, reuse sites efficiently, and maintain sites more easily. This work will also pave the way for streamlined cooperation between the municipal government and the carriers to maximize tower deployments and create denser coverage.

In an earlier engagement, 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 government. The network consists of resilient, interconnected fiber rings that will eventually connect more than 400 government buildings in the District, including Police Department facilities, the Emergency Management Agency, and Fire Department radio towers.

CTC's independent assessment analyzed public safety, governmental, 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; analyzing the ability to resell to other entities; identifying support mechanisms; and recommending business practices.

Town of Holly Springs, North Carolina: For four years, CTC has advised the Town's government as it designed and built its fiber backbone network. CTC has also assisted the Town in developing policies and strategies to attract private broadband investment, and helped the Town to identify a private sector partner—culminating in Ting Internet's October 2015 announcement that it plans to build a fiber-to-the-premises (FTTP) network leveraging the Town's fiber.[8]

CTC has supported the Town with strategic, financial, and engineering consulting services. In our first engagement, we conducted a broadband needs assessment and developed a strategic approach and return on investment analysis for the Town's proposed fiber network implementation. CTC's team of project managers, outside plant engineers, and network engineers designed and then 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.

Leisure World of Maryland: CTC has been a technical and business planning adviser to Leisure World for more than 10 years, since it assisted Leisure World in its franchise renewal with Comcast and franchise negotiations with Verizon. CTC assisted Leisure World in developing a long-range analysis of its internal and residential communications needs.

As an outcome of that analysis Leisure World leveraged existing conduit and public works resources to build a fiber network for internal use and as a resource for potential private partners to deliver residential services. CTC engineers performed OSP engineering, created an OSP fiber network design, developed engineering work drawings and an RFP for the selection of a construction contractor, and oversaw construction and QA/QC of six miles of underground fiber.

Maryland Inter-County Broadband Network (ICBN): CTC was the lead engineer for the development of the ICBN project. We designed and engineered approximately 360 miles of ICBN fiber routes for Montgomery County and three other counties.

CTC also acted as program manager and project manager for the ICBN project. We executed a strong management plan, staffing plan, and quality control plan; maintained the project plan for our work; allocated resources; tracked every aspect of the OSP process; oversaw the budgets and worked with the design team's Project Coordinators to manage deliverables and due dates; and oversaw $100 million in project funding.

During the ICBN design process, we conducted field walk-outs throughout the jurisdictions. We also worked with the State Highway Administration and the county departments of transportation to determine the availability of existing duct and cabinets, and included those in the design to cost-optimize the routes.

[8] http://www.newsobserver.com/news/local/community/southwest-wake-news/article40803345.html

We played a key role in developing ICBN design principles such as fiber quantity, storage locations, access points, and building entry; developing bills of materials (BOMs); analyzing design options (e.g., use of aerial versus underground, use of existing infrastructure); and coordinating with the environmental assessment study.

Montgomery County, Maryland: CTC has provided technical, engineering, and strategic support to Montgomery County's Department of Technology Services on its most significant recent infrastructure initiatives, including:

- *FiberNet:* CTC developed the initial design and architecture, in collaboration with the Department of Public Works and Transportation, for the network that would later become the County's FiberNet. We did this in response to the immediate need to support traffic communications and cameras—but also in response to what we saw as the County's future needs for networking, video, data services, and the Internet.

  Later, during the County's cable TV franchise renewal, we identified as a high priority the need to obtain fiber-optic infrastructure from the cable operator; this outside plant would complement the County's existing infrastructure and become part of FiberNet—and enable the County to have high availability services at a reasonable cost. As a result, the County has become a national leader in its network and enterprise capabilities.

  CTC also assists the County by providing support for the technological evolution of FiberNet, so it can better meet the growing customer demand caused by the growth of the network's physical footprint.

  Recently, CTC completed a preliminary analysis of optical network hardware platforms based on a high-level understanding of growing capacity demands and emerging requirements across FiberNet's increasingly diverse customer base. The analysis identified differentiating attributes among market-leading optical network platforms offering strategic advantages aligned with the County's objectives, and developed baseline specifications and a system-level design for an initial upgrade phase. We also evaluated options for DTS to use FiberNet to expand service to Montgomery College and Montgomery County Public Schools.

- *TFCG:* CTC is the designated Tower Coordinator for the Montgomery County Telecommunications Facilities Coordinating Group (TFCG). The TFCG model, which we created for the County, has been highlighted nationally as an example of best practices in this field. We provide technical engineering support, coordinate and review telecommunication carrier applications to site transmission facilities in the County, conduct physical inspections of proposed siting locations, review applicants' RF engineering submittals, and provide recommendations to the TFCG on each siting request based on zoning standards and other parameters. We also ensure that the County complies with the FCC's "shot clock" for processing applications.

- *UltraMontgomery*: To support development of the County's UltraMontgomery fiber infrastructure, CTC prepared a fiber market analysis, conducted a competitive assessment of the fiber market, developed a set of proposed in-building wiring standards, and identified a likely evolution path to guide the County's planning. During the initial stages of this ongoing project, we identified opportunities to cost-effectively expand County fiber to serve economic development target areas, as well as to link the County to the Equinix Data Center in Ashburn, Virginia.

- *Maryland Inter-County Broadband Network (ICBN):* CTC provided technical leadership and detailed outside plant design services for the ICBN. As the Portfolio Manager for this project, we oversaw and directed engineering and fiber network construction contractors—including the expansion of FiberNet with 132 additional miles of fiber constructed to 100 new sites.

- *NCRnet:* Through our engineering, planning, and integration efforts, the County continues to maximize the benefits of its interconnection with the National Capital Region interoperability network—supporting public safety, video conferencing, and other applications and ensuring reliable communications across jurisdictions.

National Capital Region Interoperability Program: NCRnet is a regional public safety communications network interconnecting 19 fiber-based government networks in the greater Washington, D.C. region, including Montgomery County's fiber network.

Our involvement with this project began immediately after 9/11, when we were asked by the Metropolitan Washington Council of Governments CIOs to evaluate the feasibility of such a network; that study later served as the basis of the successful grant application to the Department of Homeland Security. We were also asked to analyze the business cases for build vs. lease for each portion of the network.

Dr. Andrew Afflerbach, CTC's Director of Engineering, served as lead engineer and technical architect for planning and developing NCRnet. CTC performed a comprehensive review of existing technologies and capabilities in the individual jurisdictions, identified potential synergies and standards, and analyzed the jurisdictions' needs for security, availability, and data exchange. NCRnet's physical build-out phase was completed in 2010, followed by network electronics infrastructure upgrades that were completed in 2012.

We have been a trusted adviser and management support to the government project leadership, providing many roles including program management. During the course of our support of NCRnet, we have also performed the following tasks:

- We implemented and now oversee network monitoring systems for NCRnet and the videoconferencing network operated under the U.S. Department of Homeland Security's Urban Area Security Initiative (UASI) ESF-5a Program. The network monitoring systems

provide instant notification of network outages and help speed the repair and recovery of NCRnet and the videoconferencing network.

- We developed technical solutions for regional interconnections, initially with Montgomery County and Anne Arundel County, and later under a separate contract with the NCR interoperability program.
- We provide project management and financial management services.
- We enabled a SharePoint system and wrote a SharePoint user guide.
- We completed a risk assessment and disaster recovery strategy guide for NCRnet.

City of Palo Alto: CTC developed a fiber-to-the-premises (FTTP) master plan for the City. We worked 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.

CTC previously provided strategic guidance and advice to the City on expanding its dark fiber network to create opportunities for 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 establishing a public–private partnership to encourage greater infrastructure construction.

Prince George's County, Maryland: CTC has worked with Prince George's County continuously since 1997. CTC acted as the County's lead technical consultant for its cable negotiations with Comcast and Verizon, and has been the coordinator and engineering consultant to the County's Telecommunications Tower Facilities Coordination Committee (TTFCC) for 11 years. CTC has also provided planning and technical advice for the County I-Net, assisted in developing the I-Net governance, planned and designed the Inter-County Broadband Network (ICBN), authored the I-Net strategic plan, managed the County's cable customer complaint calls, and planned and implemented the expansion of the County's secure video-conferencing system.

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.

Wireless Communications Engineering Support Engagements

Wireless Facilities Review for Clients Nationwide: CTC reviews applications to construct wireless facilities for Baltimore, Carroll, Montgomery, and Prince George's counties in Maryland. In recent years we have also provided these services to Arlington County, Virginia; the Northern Virginia

Regional Parks Authority; Blount County, Tennessee; and the cities of Rolling Hills, California, Scarsdale, New York, and Huntsville, Alabama.

Our tower team has processed more than 3,000 applications for our clients, giving us insight into the many alternatives available to mitigate the impact of new facilities on a community—as well as an understanding of zoning standards that protect the public interest yet permit deployment of new wireless services to benefit residents.

Technical Reports for the Federal Communications Commission: CTC Director of Engineering Andrew Afflerbach, Ph.D., P.E. wrote a white paper, "Engineering Analysis of Technical Issues Raised in the FCC's Proceeding on Wireless Facilities Siting," which was filed with the FCC by the National Association of Telecommunications Officers and Advisors (NATOA). He also served as an expert advisor regarding broadband deployment to the U.S. Conference of Mayors, the National Association of Counties, the National League of Cities, and NATOA in those organizations' filings before the FCC in the matter of the deployment of a national, interoperable wireless network in the 700 MHz spectrum, which later evolved into FirstNet.

City of Annapolis, Maryland: CTC designed a broadband wireless network that serves as a backbone to link all City facilities and a citywide video surveillance system. The network has reserve capacity to support the addition of new video requirements, expanded toll-quality IP-based voice and data services, and support backhaul for a future mobile wireless solution.

City of Baltimore, Maryland: CTC is assisting the City in negotiating right-of-way agreements with distributed antenna system (DAS) and microcell network operators.

Baltimore County, Maryland: CTC provides administrative and engineering review of applications from telecommunications service providers to construct new towers for wireless service antennas. We prepare reports and recommendations to the County's Tower Review Committee for their review and approval of applications. We also attend meetings and provide comment on administrative and code-related matters as required.

City of Boulder, Colorado: CTC evaluated technical and operational options for deploying a scalable outdoor Wi-Fi network in the City's downtown area. Our goals were to ensure that the Wi-Fi design and components enabled roaming between the outdoor areas and nearby governmental buildings, provided public Wi-Fi connectivity within a defined area, and were interoperable with the City's existing infrastructure and current processes.

Carroll County, Maryland: CTC provides administrative and engineering review of applications to construct new towers for wireless service antennas. We prepare reports and recommendations to the Zoning Administrator for Facilities Location Analysis Applications. We also attend meetings and provide comment on administrative and code-related matters.

Garrett County, Maryland: CTC designed a TV White Spaces (TVWS) solution for broadband service to rural unserved areas. Our deliverables included RF models, cost estimation, field evaluation of vendor equipment, and spectrum planning.

Maryland First Microwave Network: CTC acted as lead engineer for the design and implementation of a regional microwave network to enable communications between public health agencies, hospitals, and government entities in the National Capital Region. The network provides connectivity to area hospitals for day-to-day communications and to ensure reliable communications and data sharing in the event of problems with the public communications infrastructure. This connectivity provides the transport mechanism necessary for patient tracking and other information sharing platforms.

North Central Ohio Educational Service Center (NCOESC): CTC currently is developing specifications for the design and construction of NCOESC's planned wireless point-to-point and point-to-multipoint network, which will connect school facilities across a large part of the state.

City of Palo Alto: CTC developed a wireless network plan for the City. We conducted a system-level requirements analysis and a needs assessment, and recommended wireless technologies, network designs, and business models.

Port Angeles, Washington: CTC supported the City through every step of implementing an innovative community broadband wireless project over a four-year period. CTC prepared the city's Wireless Technology Plan, including a system-level design, cost estimate, business case evaluation, and federal grant application. The project design comprised 240 wireless access points and 44 interconnections to the City's fiber network. CTC provided construction oversight and acceptance testing services, and continues to advise the City on network expansion options.

The wireless network was designed primarily to provide mobile coverage to public safety vehicles within 80 percent of the City's 10.7-square-mile land area. The same robust network architecture also enables the network to support public broadband access. The system provides client access to separate networks in 4.9 GHz (licensed) and 2.4 GHz (unlicensed, public) wireless bands. The 4.9 GHz spectrum has been reserved for public safety entities. Each of the access points is interconnected to the core backbone network through either direct connection to the City's existing fiber network or a wireless mesh-connected 5.8 GHz network.

Prince George's County, Maryland: CTC has provided independent telecommunications engineering and administrative support to the Prince George's County's Telecommunications Tower Facilities Coordination Committee (TTFCC) for 11 years. With CTC as TTFCC coordinator, the TTFCC reviewed 192 applications in FY 2014 and 287 applications in FY 2015.

2. Cost of Services

Our completed Attachment B is attached below. We will bill our work at the following hourly rates:

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

CTC's billing rates are inclusive of all routine expenses including administrative, accounting, and computer support, telephone calls, and photocopying. Non-routine expenses and long-distance travel are recovered at direct cost with no mark-up.

3. Company Information

Columbia Telecommunications Corporation (d/b/a/ CTC Technology & Energy) (CTC) is a woman-owned engineering and technology firm that assists local and state governments nationwide and the federal government. We are certified as an MBE/WBE by the Maryland Department of Transportation (certificate attached) and other jurisdictions in which we do business.

Company Name and Address

Columbia Telecommunications Corporation (d/b/a/ CTC Technology & Energy)
10613 Concord St.
Kensington, MD 20895
301.933.1488
info@ctcnet.us

CTC has satellite offices in the District of Columbia, Illinois, Minnesota, North Carolina, Washington, and Wisconsin.

Business Partners

CTC does not have any business partners. We are proudly independent, and have no financial relationship with any equipment manufacturers or vendors.

Resumes and Staff Information

CTC proposes the following staff, all of whom are employees who work from our Maryland headquarters:

- Andrew Afflerbach, Ph.D., P.E. | *CEO and Director of Engineering*
- Lee Afflerbach, P.E. | *Principal Fiber and Wireless Engineer*
- Matthew DeHaven | *Principal Fiber and Wireless Engineer*
- Kyle Doescher | *GIS Specialist and Staff Engineer*
- Ziggy Rivkin-Fish | *Principal Analyst and Governance Subject Matter Expert*
- Charlie Hamm | *GIS Specialist and Staff Engineer*
- Mitchell Hergett | *Senior Engineer*
- Robert P. Hunnicutt | *Principal Analyst and Wireless Facilities Subject Matter Expert*
- James Jordan | *Principal Outside Plant Engineer*
- Richard “Rook” Rogers | *Project Manager*
- Shawn Thompson | *Principal Engineer and Wireless Networking Subject Matter Expert*
- Eric Wirth | *Senior Fiber and Wireless Project Engineer*
- Jim Zimmermann, PMP | *Principal Engineer*

Resumes for each staff member are attached below, and their hourly rates are listed in the “Cost of Services.” As we have in our previous engagements with the LFUCG, we will seek to minimize our travel and lodging expenses for any required travel to the Lexington area.

Years Providing Technical/Consulting Services

CTC has provided technical and consulting services to local government clients since our founding in 1983.

References

REFERENCE 1	
Client Name	Commonwealth of Kentucky, Office of Technology
Street Address	101 Cold Harbor Dr.
City, State, Zip Code	Frankfort, KY 40601
Contact Person/E-mail	Mr. Mike Hayden, mike.hayden@ky.gov
Title	Chief Operating Officer, Kentucky Communications Network Authority
Telephone Number	(502) 782-2535
Service Dates	2013 to present

REFERENCE 2	
Client Name	Montgomery County, Maryland – Dept. of Technology Services
Street Address	101 Monroe St., 13th floor - Room 1313
City, State, Zip Code	Rockville, MD 20850
Contact Person/E-mail	Mitsuko Herrera, mitsuko.herrera@montgomerycountymd.gov
Title	ultraMontgomery Program Director
Telephone Number	(240) 777-2928
Service Dates	2004 to present

Attachment A: Technology

Attachment A contains a list of the technologies used by the Lexington-Fayette Urban County Government. Please enter the average experience (years) of qualified employees who may provide IT services in the Experience column. You may enter the number of employees the average applies to, e.g. "5 years, 3 employees". The Comments column should be used to provide LFUCG with information that should be considered during the vendor selection process.

Technology	Experience	Comments
Microsoft Windows 2003, 2008, 2012, 2016	N/A	
Microsoft Windows 7, 8, 10 Desktop	N/A	
Microsoft Office 365, Architecture and	N/A	
Microsoft PowerShell	N/A	
Microsoft Active Directory	N/A	
Microsoft Exchange 2010, 2013	N/A	
AIX versions 5.x, 6.x, 7.x	N/A	
Linux	N/A	
Internet Information Server (IIS)	N/A	
F5 BigIP	N/A	
VMware	N/A	
VMware VirtualCenter	N/A	
VMware ESX	N/A	
Microsoft Access	N/A	
Microsoft SQL Server 2008, 2012, 2014, 2016	N/A	
Oracle Database 10, 11, 12, 13	N/A	
SharePoint Services (on premise and cloud)	N/A	
Microsoft Office SharePoint Server	N/A	
Microsoft .NET Framework 2+	N/A	
Microsoft Project Server	N/A	
ESRI Geodatabase (10.2.1 and higher)	N/A	
ESRI ArcGIS for Server (10.2.1 and higher)	N/A	
ESRI ArcGIS for Desktop (10.2.1 and higher)	N/A	
ESRI ArcGIS Online (10.2.1 and higher)	N/A	
ESRI ArcReader (10.2.1 and higher)	N/A	
Visual Studio	N/A	
VBA	N/A	
Python	N/A	
JavaScript	N/A	
HTML5	N/A	
C#	N/A	
C++	N/A	
Ruby	N/A	
Ruby on Rails	N/A	
Visual Basic 6.0	N/A	

Technology	Experience	Comments
ASP.NET	N/A	
VB.NET	N/A	
jQuery	N/A	
Web Services	N/A	
PHP Development	N/A	
RPG IV	N/A	
BCD Presto	N/A	
ADO	N/A	
Moodle	N/A	
AJAX	N/A	
Technology	N/A	
Node.js	N/A	
Chef, Puppet, Troposphere	N/A	
Amazon Web Services (AWS) Architecture	N/A	
Amazon Web Services (AWS) DevOps	N/A	
Microsoft Azure Architecture	N/A	
Microsoft Azure DevOps	N/A	
Palo Alto Firewalls	N/A	
Splunk	N/A	
Switching & Routing	N/A	
Vulnerability Scanning (Nessus)	N/A	
Patch Management	N/A	
IBM BigFix	N/A	
PeopleSoft HCM 9.0	N/A	
PeopleSoft FSCM 8.9	N/A	
PeopleTools 8.49	N/A	

Attachment B: Cost

Attachment B contains a list of services the Lexington-Fayette Urban County Government may need provided. Please use the notes column to identify any information that should be considered during the vendor selection process. Exceptions to billing should be included in the notes, e.g. weekend rate adjustments.

Service		Rate	Notes
Software Development	ASP.NET C# JavaScript Ruby Ruby on Rails C++ HTML5 VB.NET Python Visual Basic 6.0 ESRI ArcGIS ADO 2.X + Web Services Microsoft Access	N/A	
Database Design	SQL Server SQL Server Express MySQL ESRI Enterprise Geodatabase Oracle	N/A	
Consulting	~~Disaster Recovery/Bus Continuity~~ Technical Requirements Gathering IT Strategic Planning IT Governance IT Project Management Certified Project Management (PMP) Network Technologies ~~Software Development~~ ~~PeopleSoft HCM (9.0)~~ ~~PeopleSoft FSCM (8.9)~~	See Section 2 ("Cost of Services") for CTC's hourly rates for these proposed services	
Server Application Implementation	Microsoft SharePoint Microsoft Project Server Microsoft SQL Server Microsoft Exchange Microsoft Windows VMware Virtual Center VMware ESX	N/A	

Service		Rate	Notes
Training	Microsoft SharePoint Microsoft Project Server Microsoft SQL Server Visual Studio Team Suite Visual Studio 2008 VMware	N/A	
Network Support	F5 BigIP Microsoft Active Directory Microsoft Windows VMware	N/A	
Information Security	Policy Development and Review Planning and Analysis Penetration Testing Vulnerability Testing Risk Management Assessment Info Security Audit and Compliance Info Security Remediation Info Security End-User Training	N/A	
Enterprise DevOps & "Cloud"	Cloud Architecture and Design Code Deployment and Maintenance Enterprise System Administration Version Control Infrastructure as Code (IaC) Platform as a Service (Paas) Software as a Service (SaaS) Infrastructure as a Service (IaaS)	N/A	

Appendix 1: MBE/DBE/SBE Certification

Maryland Department of Transportation
The Secretary's Office

Larry Hogan
Governor

Boyd Rutherford
Lt. Governor

Pete K. Rahn
Secretary

June 30, 2015

JOANNE S. HOVIS
COLUMBIA TELECOMMUNICATIONS CORPORATION
10613 CONCORD STREET
KENSINGTON, MD 20895

Re: ANNUAL REVIEW

Dear JOANNE S. HOVIS (cert # 05-151):

We are pleased to inform you that your company is eligible to continue participation in the programs and services on the attached Programs and Services List.

Your current certification status can be found in the Maryland Department of Transportation's (MDOT) Directory of certified firms available online at http://mbe.mdot.state.md.us/directory. MDOT's online Directory is the official record of your firm's certification status. It is important that you review the accuracy of your listing in the Directory.

If you wish to expand the area(s) of work for which your firm is currently certified, you may request an expansion of services. The application for an expansion of services can be found at http://www.mdot.maryland.gov/Office of Minority Business Enterprise/ExpansionCover.html Please submit your expansion application to:

Maryland Department of Transportation
Office of Minority Business Enterprise
7201 Corporate Center Drive
Hanover, MD 21076
410-865-1309 (fax)

Your firm must complete the annual review to maintain its certification. The OMBE will provide notification when it is time to begin the next annual review. If you have any questions regarding your certification status please contact the OMBE at (410) 865-1269 or 1 (800) 544-6056.

Sincerely,

Randy Reynolds
Director, Minority Business Enterprise

My telephone number is _____
Toll Free Number 1-888-713-1414 TTY Users Call Via MD Relay
7201 Corporate Center Drive, Hanover, Maryland 21076

Maryland Department of Transportation
The Secretary's Office

Larry Hogan
Governor

Boyd Rutherford
Lt. Governor

Pete K. Rahn
Secretary

June 30, 2015

COLUMBIA TELECOMMUNICATIONS CORPORATION
10613 CONCORD STREET
KENSINGTON, MD 20895

CERTIFICATION NUMBER: 05-151

PROGRAMS AND SERVICES LIST

Your firm is currently certified in the below programs and services. If you have any questions or concerns regarding the below information please contact the Maryland Department of Transportation's Office of Minority Business Enterprise at (410) 865-1269 or 1-(800) 544-6056.

CERTIFICATION: **MBE/DBE/SBE**
NAICS CODE: **541611**
SERVICE(S): **ADMINISTRATIVE MANAGEMENT AND GENERAL MANAGEMENT CONSULTING SERVICES**

CERTIFICATION: **MBE/DBE/SBE**
NAICS CODE: **541618**
SERVICE(S): **OTHER MANAGEMENT CONSULTING SERVICES**

My telephone number is _____
Toll Free Number 1-888-713-1414 TTY Users Call Via MD Relay
7201 Corporate Center Drive, Hanover, Maryland 21076

Appendix 2: Affidavit and Affirmative Action Plan

Attached here are the following required forms:

1. Affidavit
2. LFUCG MWDBE Participation Form
3. Equal Opportunity Agreement and Work Force Analysis Form
4. LFUCG Statement of Good Faith Efforts

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AFFIDAVIT

Comes the Affiant, Joanne Hovis, and after being first duly sworn, states under penalty of perjury as follows:

1. His/her name is Joanne Hovis and he/she is the individual submitting the proposal or is the authorized representative of Columbia Telecommunications Corporation (d/b/a CTC Technology & Energy), the entity submitting the proposal (hereinafter referred to as "Proposer").

2. Proposer will pay all taxes and fees, which are owed to the Lexington-Fayette Urban County Government at the time the proposal is submitted, prior to award of the contract and will maintain a "current" status in regard to those taxes and fees during the life of the contract.

3. Proposer will obtain a Lexington-Fayette Urban County Government business license, if applicable, prior to award of the contract.

4. Proposer has authorized the Division of Central Purchasing to verify the above-mentioned information with the Division of Revenue and to disclose to the Urban County Council that taxes and/or fees are delinquent or that a business license has not been obtained.

5. Proposer has not knowingly violated any provision of the campaign finance laws of the Commonwealth of Kentucky within the past five (5) years and the award of a contract to the Proposer will not violate any provision of the campaign finance laws of the Commonwealth.

6. Proposer has not knowingly violated any provision of Chapter 25 of the Lexington-Fayette Urban County Government Code of Ordinances, known as "Ethics Act."

Continued on next page

7. Proposer acknowledges that "knowingly" for purposes of this Affidavit means, with respect to conduct or to circumstances described by a statute or ordinance defining an offense, that a person is aware or should have been aware that his conduct is of that nature or that the circumstance exists.

Further, Affiant sayeth naught.

Joanne S. Hovis

STATE OF Maryland

COUNTY OF Montgomery

The foregoing instrument was subscribed, sworn to and acknowledged before me by Joanne Hovis on this the 25th day of April, 2016.

My Commission expires: 01/02/2018

HELEN VESKE
Notary Public-Maryland
Prince George's County
My Commission Expires
January 02, 2018

NOTARY PUBLIC, STATE AT LARGE

LFUCG MWDBE PARTICIPATION FORM
Bid/RFP/Quote Reference # 13-2016

The MWDBE subcontractors listed have agreed to participate on this Bid/RFP/Quote. If any substitution is made or the total value of the work is changed prior to or after the job is in progress, it is understood that those substitutions must be submitted to Central Purchasing for approval immediately.

MWDBE Company, Name, Address, Phone, Email	Work to be Performed	Total Dollar Value of the Work	% Value of Total Contract
1. Columbia Telecommunications Corporation d/b/a CTC Technology and Energy	All Tasks		100%
2.			
3.			
4.			

The undersigned company representative submits the above list of MWDBE firms to be used in accomplishing the work contained in this Bid/RFP/Quote. Any misrepresentation may result in the termination of the contract and/or be subject to applicable Federal and State laws concerning false statements and false claims.

CTC Technology and Energy
Company

Joanne S. Hovis, Joanne Hovis
Company Representative

4-25-16
Date

President
Title

CTC Proposal to the LFUCG (RFP # 13-2016)

EQUAL OPPORTUNITY AGREEMENT

The Law

- Title VII of the Civil Rights Act of 1964 (amended 1972) states that it is unlawful for an employer to discriminate in employment because of race, color, religion, sex, age (40-70 years) or national origin.

- Executive Order No. 11246 on Nondiscrimination under Federal contract prohibits employment discrimination by contractor and sub-contractor doing business with the Federal Government or recipients of Federal funds. This order was later amended by Executive Order No. 11375 to prohibit discrimination on the basis of sex.

- Section 503 of the Rehabilitation Act of 1973 states:

  The Contractor will not discriminate against any employee or applicant for employment because of physical or mental disability.

- Section 2012 of the Vietnam Era Veterans Readjustment Act of 1973 requires Affirmative Action on behalf of disabled veterans and veterans of the Vietnam Era by contractors having Federal contracts.

- Section 206(A) of Executive Order 12086, Consolidation of Contract Compliance Functions for Equal Employment Opportunity, states:

  The Secretary of Labor may investigate the employment practices of any Government contractor or sub-contractor to determine whether or not the contractual provisions specified in Section 202 of this order have been violated.

****

The Lexington-Fayette Urban County Government practices Equal Opportunity in recruiting, hiring and promoting. It is the Government's intent to affirmatively provide employment opportunities for those individuals who have previously not been allowed to enter into the mainstream of society. Because of its importance to the local Government, this policy carries the full endorsement of the Mayor, Commissioners, Directors and all supervisory personnel. In following this commitment to Equal Employment Opportunity and because the Government is the benefactor of the Federal funds, it is both against the Urban County Government policy and illegal for the Government to let contracts to companies which knowingly or unknowingly practice discrimination in their employment practices. Violation of the above mentioned ordinances may cause a contract to be canceled and the contractors may be declared ineligible for future consideration.

Please sign this statement in the appropriate space acknowledging that you have read and understand the provisions contained herein. Return this document as part of your application packet.

Bidders

I/We agree to comply with the Civil Rights Laws listed above that govern employment rights of minorities, women, Vietnam veterans, handicapped and aged persons.

Joanne S. Horn
Signature

Columbia Telecommunications Corporation d/b/a CTC Technology and Energy
Name of Business

WORKFORCE ANALYSIS FORM

Name of Organization: Columbia Telecommunications Corporation d/b/a CTC Technology and Energy

Categories	**Total**	White (Not Hispanic or Latino)		Hispanic or Latino		Black or African-American (Not Hispanic or Latino		Native Hawaiian and Other Pacific Islander (Not Hispanic or Latino		Asian (Not Hispanic or Latino		American Indian or Alaskan Native (not Hispanic or Latino		Two or more races (Not Hispanic or Latino		**Total**	
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Administrators																	
Professionals	36	26	7			1					2					27	9
Superintendents																	
Supervisors																	
Foremen																	
Technicians																	
Protective Service																	
Para-Professionals																	
Office/Clerical	4		3				1										4
Skilled Craft																	
Service/Maintenance																	
Total:	40	26	10			1	1				2					27	13

Prepared by: Joanne Hovis, President **Date: 4/25/16**

(Name and Title) ***Revised 2015-Dec-15***

LFUCG STATEMENT OF GOOD FAITH EFFORTS
Bid/RFP/Quote # 13-2016

By the signature below of an authorized company representative, we certify that we have utilized the following Good Faith Efforts to obtain the maximum participation by MWDBE business enterprises on the project and can supply the appropriate documentation.

_____ Advertised opportunities to participate in the contract in at least two (2) publications of general circulation media; trade and professional association publications; small and minority business or trade publications; and publications or trades targeting minority, women and disadvantaged businesses not less than fifteen (15) days prior to the deadline for submission of bids to allow MWDBE firms to participate.

_____ Included documentation of advertising in the above publications with the bidders good faith efforts package

_____ Attended LFUCG Central Purchasing Economic Inclusion Outreach event

_____ Attended pre-bid meetings that were scheduled by LFUCG to inform MWDBEs of subcontracting opportunities

_____ Sponsored Economic Inclusion event to provide networking opportunities for prime contractors and MWDBE firms

_____ Requested a list of MWDBE subcontractors or suppliers from LFUCG Economic Engine and showed evidence of contacting the companies on the list(s).

_____ Contacted organizations that work with MWDBE companies for assistance in finding certified MWBDE firms to work on this project. Those contacted and their responses should be a part of the bidder's good faith efforts documentation.

_____ Sent written notices, by certified mail, email or facsimile, to qualified, certified MWDBEs soliciting their participation in the contract not less that seven (7) days prior to the deadline for submission of bids to allow them to participate effectively.

_____ Followed up initial solicitations by contacting MWDBEs to determine their level of interest.

_____ Provided the interested MWBDE firm with adequate and timely information about the plans, specifications, and requirements of the contract.

_____ Selected portions of the work to be performed by MWDBE firms in order to increase the likelihood of meeting the contract goals. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate MWDBE participation, even when the prime contractor may otherwise perform these work items with its own workforce

_____ Negotiated in good faith with interested MWDBE firms not rejecting them as unqualified without sound reasons based on a thorough investigation of their capabilities. Any rejection should be so noted in writing with a description as to why an agreement could not be reached.

_____ Included documentation of quotations received from interested MWDBE firms which were not used due to uncompetitive pricing or were rejected as unacceptable and/or copies of responses from firms indicating that they would not be submitting a bid.

_____ Bidder has to submit sound reasons why the quotations were considered unacceptable. The fact that the bidder has the ability and/or desire to perform the contract work with its own forces will not be considered a sound reason for rejecting a MWDBE quote. Nothing in this provision shall be construed to require the bidder to accept unreasonable quotes in order to satisfy MWDBE goals.

_____ Made an effort to offer assistance to or refer interested MWDBE firms to obtain the necessary equipment, supplies, materials, insurance and/or bonding to satisfy the work requirements of the bid proposal

_____ Made efforts to expand the search for MWDBE firms beyond the usual geographic boundaries.

__X__ Other - any other evidence that the bidder submits which may show that the bidder has made reasonable good faith efforts to include MWDBE participation. **Columbia Telecommunications Corporation d/b/a CTC Technology and Energy is a certified WBE/DBE firm in numerous states and jurisdictions. See attached certifications.**

Failure to submit any of the documentation requested in this section may be cause for rejection of bid. Bidders may include any other documentation deemed relevant to this requirement. Documentation of Good Faith Efforts are to be submitted with the Bid, if the participation Goal is not met.

The undersigned acknowledges that all information is accurate. Any misrepresentations may result in termination of the contract and/or be subject to applicable Federal and State laws concerning false statements and claims.

Columbia Telecommunications Corporation
d/b/a CTC Technology and Energy
Company

Joanne S. Hovis, Joanne Hovis
Company Representative

4-25-16
Date

President
Title

Technical Resumes

Attached here are resumes for the CTC team.

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 Delaware Department of Transportation; 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.
- 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, Public Knowledge, New America Foundation Open Technology Institute, 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 sought advice on technology from a consultant—a reflection of the lack of standards in the Smart

Grid arena.

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)
- NATOA representative to SAFECOM Emergency Response Committee
- 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)
- Walter Johnson High School Crew Team, technical/computer advisor

- 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, filed with the FCC, Nov. 2014
- "The State of the Art and Evolution of Cable Television and Broadband Technology," prepared for Public Knowledge, filed with the FCC, Nov. 2014
- "A Model for Understanding the Cost to Connect Schools and Libraries with Fiber Optics," prepared for the Schools, Health & Libraries Broadband Coalition, filed with the FCC, Oct. 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, Mar./Apr. 2014
- "Engineering Analysis of Technical Issues Raised in the FCC's Proceeding on Wireless Facilities Siting," (http://apps.fcc.gov/ecfs/document/view?id=7521070994) filed with the FCC, Feb. 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, Jan. 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), Jan. 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., Apr. 2013
- "Connected Communities: How a City Can Plan and Implement Public Safety & Public Wireless," submitted to the International Wireless Communications Exposition, Las Vegas, Mar. 2013
- "Cost Estimate for Building Fiber Optics to Key Anchor Institutions," prepared for submittal to the FCC by NATOA and SHLB, Sept. 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, Aug. 25, 2009
- "Existing and Emerging Broadband Technologies," NATOA Conference, Oct. 2007
- "An Assessment of the Technical Capabilities of the AWS-3 Spectrum," expert report prepared for Free Press, Dec. 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, Nov. 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," 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, Jan. 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, Sept. 1998
- "I-Nets and the Internet," Infotech Report, Aug. 1998
- "Integrated Data, Video & Voice Broadband Networks" and "Design & Implementation of Metropolitan Area Networks (MANs)," presented at the 1998 COMNET Exposition

Lee Afflerbach, P.E. | Principal Fiber and Wireless Engineer

Lee Afflerbach is a telecommunications systems engineer with 40 years of experience serving federal, state, and local government clients. Mr. Afflerbach's expertise covers a wide range of broadband (video, voice, and data) communications technology. He has designed, tested, and planned numerous wireless, coaxial cable, telecommunications, and fiber optic networks for government, public safety, educational, and non-profit clients.

Mr. Afflerbach's extensive experience and expertise in both wireless and wired technologies results from years of evaluating and meeting emerging communications needs for government in general—and public safety agencies in particular. He has designed command and control centers for transportation agencies, has designed 911 systems, has developed communications design and requirements for highway systems; and has developed standards and assured compliance with standards for public safety communications equipment.

Among his recent projects are:

- A significant, multi-year wireless network planning engagements on behalf of the **State of Delaware Department of Transportation**. Mr. Afflerbach wrote the statewide master plan for deploying an integrated broadband fiber and microwave network. He has also advised the state on its statewide 700 MHz mobile data network, including a requirements analysis, propagation studies, and system design.
- Mr. Afflerbach developed a wireless network plan for the **City of Palo Alto**. He conducted a system-level requirements analysis and a needs assessment, and recommended wireless technologies, network designs, and business models. He previously provided strategic guidance and advice to the City on expanding its dark fiber network to create opportunities for enhanced municipal and commercial services. In that engagement, he assessed how to leverage existing infrastructure to promote commercial wireless broadband deployment and improve municipal Smart Grid and public safety technologies. He also prepared a framework for how to establish a public-private partnership to encourage greater wireline infrastructure construction.
- Over the course of a four-year engagement, Mr. Afflerbach guided the **City of Port Angeles, Washington** from needs assessment and feasibility analysis through to design and implementation of a citywide broadband wireless network project that will provide integrated communications and interoperability among all local public safety entities in the city. The high-capacity 4.9 GHz broadband wireless network provides public safety staff with access to state, federal, and GIS databases, and allows EMS responders to access medical databases and support on-site telemetry of patient status. A commercial open-access multi-provider wireless access system was deployed as a public–private partnership with a local ISP; it provides citywide Wi-Fi services in the 2.4 GHz band.

Mr. Afflerbach is a licensed Professional Engineer and a nationally recognized authority on wired and wireless communications. He has served as a consultant and expert witness for public sector clients and has taught numerous courses in broadband communications technology, both in the United States and abroad, including in the United Kingdom, Germany, and the Netherlands (Amsterdam).

Communications Network Engineering

Mr. Afflerbach has planned and designed communications networks for numerous municipalities, including Montgomery County, MD; New York City; Baltimore; Cincinnati; Tampa; Santa Monica; Ventura; Tucson; Austin; and St. Paul. These stand-alone broadband networks employ a range of wired and wireless technology to provide video, voice, and data capability within and between municipal facilities.

Mr. Afflerbach has assisted local governments in the cable franchise renewal process, providing technical expertise on state-of-the-art network technologies. He has presented workshops to network users on requirements analysis and system solutions. He has conducted requirements analyses, prepared system-level network designs, provided construction coordination with the cable operator, and supported network integration with existing municipal networks. Mr. Afflerbach provides technical franchise renewal support to such communities as Los Angeles, San Francisco, and San Jose.

Over the course of his long career in broadcast engineering, Mr. Afflerbach has conducted feasibility analyses to support the authorization of new broadcast facilities. Activities included the study of groundwave and skywave propagation in the 550 kHz-900 MHz spectrum range; and evaluation of potential interference areas, service area losses, and compliance with international treaties.

Some select examples of his work include:

- Planned, designed, and oversaw build of citywide fiber network for agency needs for New York City. *On 9/11 in Lower Manhattan, every network but one failed; the surviving network was designed by CTC.*
- Design and integration solution for cablecast channel for Monterey County. Analyzed the existing audio visual and broadcast systems and developed recommendations for future development. Designed an IP-based video server system capable of recording and airing live meetings and scheduling cable/broadcasts. Completed on-site integration, testing, and training on the video server system.
- Prepared a design for a video transmission and switching system for the City of Santa Clara. The system provides links between multiple sites for video programming that is transmitted over the channel on the cable system. The system is also designed to allow basic video conferencing between the origination locations.

- Prepared the design for the fiber optic network interconnecting Gilroy, Hollister, and San Juan Bautista to a shared programming center. In addition, the design allowed the interconnection of the communities for data networking and potential video conferencing.

Public Safety Network Interoperability and Interconnection

Mr. Afflerbach has been instrumental in the development and implementation of an Enhanced Traffic Advisory Radio System (E-TARS) for the State of Delaware that uses statewide radio signals to distribute traffic and emergency information collected by Delaware's Intelligent Transportation Management System (ITMS). He was also involved in similar efforts for the Georgia Department of Transportation; Arlington County, VA; and Howard County, MD.

Mr. Afflerbach developed a design and deployment strategy for the Howard County Office of Emergency Management and the Arlington County Office of Emergency Management for an AM broadcast radio system to disseminate information to the public during emergency situations. In Howard County, he assisted the County to obtain AM broadcast radio licenses and developed candidate system designs.

Land-Mobile Communications System Design

Under funding provided by the Law Enforcement Assistance Administration (LEAA), Mr. Afflerbach performed and managed communications design studies for federal, state, and local law enforcement agencies, including the Federal Bureau of Investigation (FBI), Drug Enforcement Administration (DEA), New York State Police, and Georgia State Police. Tasks involved user requirements analysis, system design, and specification preparation for land-mobile radio, computer-assisted dispatching, and 911 emergency telephone systems.

Instruction/Expertise

Mr. Afflerbach has prepared training courses providing information on communications designs, applications, and operations. The courses have been presented at George Washington University, ITS America, University of Maryland, COMNET, University of Alabama, and the National Security Agency.

EMPLOYMENT HISTORY

Since 1983	Columbia Telecommunications Corporation (CTC), *Principal Engineer*
1983	Established CTC
1981 – 1983	The Bertman Group, *Vice President of Engineering*, Vienna, VA
1971 – 1981	MITRE Corporation, *Group Leader*, McLean, VA and Frankfurt, Germany
1969 – 1971	Kelly Scientific Corporation, *Project Manager*, Washington, D.C.
1966 – 1969	Federal Communications Commission, *Staff Engineer*, Washington, D.C.

EDUCATION

Bachelor of Arts, Electrical Engineering, Drexel University, 1966

PROFESSIONAL CERTIFICATIONS/LICENSES
Professional Engineer—Delaware, District of Columbia, Illinois, Maryland, Washington

HONORS/ORGANIZATIONS
National and Maryland Societies of Professional Engineers (NSPE)
Institute of Electrical and Electronic Engineers (IEEE) — Broadcast & Computer Societies
National Association of Telecommunications Officers and Advisors (NATOA)

SELECTED PUBLICATIONS/PRESENTATIONS/COURSES

- Principal author, "Telecommunications and ITS: What You Need to Know," course module, prepared for University of Maryland Center for Advanced Transportation Technology, 2002.
- "Telecommunications and ITS: What You Need to Know," prepared curriculum for two-day training course for the University of Maryland, 2001.
- "Telecommunications and Intelligent Transportation Services," two-day training course, presented in multiple cities for 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, College Park, Maryland, 1999.
- "Integrated Data, Video & Voice Broadband Networks," week-long training course, presented at the COMNET Exposition, Washington, D.C., 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, September 1983 through May 1999.

Matthew DeHaven | Principal Fiber and Wireless Engineer

Matthew DeHaven specializes in wired and wireless communications and broadband telecommunications technology for public safety and other local government and institutional needs. He has over 13 years of extensive engineering experience designing, developing, installing, and overseeing integration of local and wide area networks for institutional, public safety, and Intelligent Transportation System (ITS) applications, video-networking solutions, and unified communications systems.

Mr. DeHaven has experience at many levels of network design, procurement, and implementation for high-capacity metropolitan-area networks to support converged video, voice, and data communications. He leads network designs and the preparation of specifications for competitive bid processes, serves as project manager overseeing implementation and testing for a wide range of government clients. Mr. DeHaven prepares designs and cost models to support decision-makers in the deployment of a range of data network technologies, traditional telephone systems, voice-over-IP (VoIP) networks, one-way video distribution, and two-way videoconferencing. His data network experience includes work with SONET, Ethernet, and ATM networks using a range of fiber optic, copper, and wireless technologies. He serves as CTC's lead engineer on numerous wide area network projects.

Among many other projects, he served as a one of the primary technical architects for the 19 jurisdiction fiber optic/microwave network currently deployed in the National Capital Region (NCRnet) to support public safety interoperable communications.

Inter-County Broadband Network

Originally serving as part of the grant application development team that successfully led the State of Maryland to a $115 million Broadband Technology Opportunities Program (BTOP) administered by the National Telecommunications and Information Administration (NTIA), Mr. DeHaven currently serves as the Portfolio Manager for the One Maryland Inter-County Broadband Network BTOP grant project.

The ICBN is a nine-jurisdiction consortium in central Maryland led by Howard County, Maryland, and is a key sub-recipient of the State's grant award. Mr. DeHaven is the lead technical consultant overseeing the use of approximately $72 million in grant funds to build over 800 miles of fiber optics and directly connect approximately 650 community anchor institutions, including schools, libraries, government buildings, community colleges, and public safety agencies. Mr. DeHaven is tasked with overseeing numerous engineering and construction contractors, as well as playing a key role in overall network design during this aggressive three-year endeavor that began in late 2010.

Wireless Communications

Mr. DeHaven assesses clients' existing and projected wireless broadband needs and recommends potential strategies for using new technologies to enhance and improve network operations and services. Some select examples of his ongoing and past projects include:

- Engineering support of the ongoing deployment of a citywide 4.9 GHz public safety radio mesh network for the City of Port Angeles, WA. CTC conducted a needs assessment of the city's network and reviewed public safety mobile data communications considerations, which led to the development of network specifications and overseeing the procurement for the expansion of the city's fiber network and a citywide wireless network serving both public safety and public access needs.
- Provided an updated assessment and review to Cincinnati, OH of the city's current networks and recommended updates to the long-term strategic plan originally prepared in 2004. This project involves assessing and identifying new department and network application needs, assessing the current networks to meet identified needs, assessing emerging fiber and wireless technologies, recommending wireless strategies, and providing recommendations and strategies for meeting foreseeable needs.
- Developed a strategic plan for a wireless data network to meet public safety and local government needs in Seattle, WA. CTC previously conducted a feasibility study that identified these needs.
- Design of a broadband wireless network for Annapolis, MD that provides connectivity for a citywide video surveillance system. The network was designed to provide high-degrees of security and has substantial reserve capacity to support the addition of new video requirements, expand toll-quality IP-based voice and data services, and, potentially, provide backhaul for a future mobile wireless solution.
- Oversight of the design and implementation of a "wireless downtown" for Skokie, IL to enhance economic development and Internet accessibility for residents and visitors.
- Project oversight in developing an infrastructure plan to support the implementation of WiFi services throughout a downtown area targeted for economic development in Rockville, MD. The plan focuses on deploying a flexible architecture of physical support infrastructure to enable a wide range of wireless connectivity options for visitors, residents, and business tenants while maintaining the aesthetics of the development.
- Evaluation of bids from wireless service providers who responded to the city of Mesa, AZ's RFP. CTC also, in an earlier phase of the project, provided an assessment of WiFi technology and potential expansion of the fiber-optic infrastructure via mass wireless communications—potentially for an intelligent transportation system application and for free Internet access for citizens.
- Research on current and future wireless technologies and evaluation of the feasibility of implementing a secure public safety wireless network in Prince George's County, MD. Designed and implemented a pilot project to test the feasibility of a public safety network. A successful solution was deployed to enable Mobile Data Computers in emergency response vehicles to securely roam from a carrier CDMA network to private, County-operated WiFi hotspots.

Public Safety Networking

In addition to supporting the design and deployment of NCRnet, Mr. DeHaven is the lead engineer responsible for one of the key applications leveraging this regional network. Mr. DeHaven is responsible for the design, implementation, and ongoing operations of a regional videoconferencing network supporting Emergency Management among the 21 jurisdictions in the National Capital Region (DC, MD, VA). CTC developed the systems' designs and oversaw implementation under a grant from the Department of Homeland Security Urban Areas Security Initiative (UASI). This network now serves thousands of end users, integrated tightly with the ever growing videoconferencing and VoIP systems leveraged by these jurisdictions.

In Anne Arundel County, MD, Mr. DeHaven assisted with the deployment of traffic surveillance cameras. He provided analysis of candidate technical solutions for cameras using the County's high-speed fiber-optic I-Net to transport video and control signals, developed system specifications, and oversaw the implementation of the County's video surveillance capabilities.

Mr. DeHaven was also involved in the planning and implementation of a statewide network in Delaware for the purpose of providing traffic information and traffic control capabilities to transportation management facilities. Such a network allows remote control of traffic signal systems and variable message displays, while providing real-time traffic surveillance in the form of video images and microwave sensor data. He has developed expertise in the numerous forms of technology used in this type of project, ranging from fiber optics to wireless digital spread-spectrum communications.

Mr. DeHaven serves as CTC's lead engineer for the Delaware Department of Transportation's Advanced Traffic Advisory Radio System, the first Advanced TARS system in the country. In that capacity, he is responsible for training and advising on-site staff, specifying and installing new equipment, and monitoring performance of the system.

Video and Broadcast Communications Engineering

Mr. DeHaven's experience includes the management, design, and procurement of video, voice, and data networks. Some select examples of his recent project work include:

- Analysis of the technical options to allow The Rockville Channel (Rockville, MD) to support live cablecasting from multiple facilities, including the implementation of an IP-based video and audio transmission system. He also managed the relocation of the master control and studio production systems for The Rockville Channel. CTC successfully executed the relocation during the tight window of opportunity between live production events, while making enhancements to system layout and cabling infrastructure and keeping the channel "on-air" during the process.
- Development and implementation of videoconferencing and teleconferencing tools for the 21 jurisdictions in the National Capital Region (DC, MD, VA) Emergency Operations Centers (EOCs) and Emergency Communications Centers (ECCs) over a state-of-the-art fiber-optic and microwave network.
- Preparation of system-level design recommendations and cost estimates for an extensive, countywide system to support interactive and on-demand video training communications

for the Anne Arundel (MD) County Fire Department. CTC also developed the design for a video display system for the Fire Department's new dispatch center, intended to allow key sources of information to be prominently displayed throughout the facility.

- Preparation of system-level design recommendations and cost estimates for an extensive, citywide system to support interactive and on-demand video communications for training, emergency collaboration, and routine meetings between Mesa, AZ Fire Department personnel. CTC also integrated a pilot videoconferencing system to demonstrate certain capabilities of the system design.
- Development of a videoconferencing system for homeland security applications on behalf of Arlington County, VA—the site of the September 11, 2001 Pentagon attack. The system links numerous public safety and other government users and aims to ensure uninterrupted emergency communications in the event of a terrorist attack or natural disaster.

Instruction/Expertise

Mr. DeHaven led the CTC research team in preparing Web-based Intelligent Transportation System (ITS)-Communications courses on behalf of the University of Maryland Center for Advanced Transportation Technology. He has served as an online instructor for these courses for more than six years.

EDUCATION

Bachelor of Science, Electrical Engineering**,** in progress, The Johns Hopkins University

SELECTED PUBLICATIONS and COURSES

- "What's the Fuss About Fiber? A Comparative Analysis of Fiber and Copper Physical Media," Journal of Municipal Telecommunications Policy, Spring 2009.
- "Deploying Public Safety Networks: Costs and Benefits – 4.9 GHz for Video Surveillance," presented at annual SEATOA Conference, April 2008.
- "Busting the Technology Myths," presented at NATOA Conference, October 2007.
- "WiFi and Beyond: Taming Technology for your Community," presented at the annual TATOA Conference, August 2007.
- "Looking Beyond Traditional I-Nets: NSCC Case Study," presented at the annual TATOA Conference, August 2007.
- "Magical Solutions for Public Safety Wireless," presented to the National Association of Telecommunications Officers and Advisers, September 2006.
- "VoIP and Enhanced 911 Services: A Primer on the Technology and its Limitations," Journal of Municipal Telecommunications Policy, Fall 2005.
- "IP Technologies: An Overview for Local Government," presented at the annual NATOA Conference, September 2005.
- "Homeland Security Applications Over the I-Net," NATOA Conference, 2002.

Kyle Doescher | GIS Specialist and Staff Engineer

Kyle Doescher works with a range of geographic design programs—including ESRI ArcGIS, Google Earth, and OSPInSight—to enable large-scale network design and construction projects, as well as to illustrate geographic data for feasibility studies. He creates maps to support network route planning, utility pole attachment, and permit application processes.

Kyle 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 map of data from the annual plan for cellular service providers in the county

Village of Bald Head Island, North Carolina

- Generated fiber routes based on service area requirements
- Estimated construction costs based on the construction design

City of Westminster, Maryland

- Created GIS database of as-built data for FTTP pilot project construction
- Performed OTDR testing for fiber acceptance

New Mexico Public School Facilities Authority

- Geocoded survey results to generate GIS maps
- Created GIS maps that demonstrated geographic trends in survey data

Anne Arundel County, Maryland

- Created GIS database of Anne Arundel I-Net construction project using OSPInSight software
- Created shapefiles for incorporation into the county's GIS database
- Assisted CTC engineers in creating system-level drawings of proposed construction routes
- Created and update engineering designs in GIS database
- Used Visio to create graphics of engineering designs
- Developed overview maps of the engineering designs for project managers
- Conducted field visits to document inside plant engineering designs for government sites

City of Atlanta

- Analyzed data on existing fiber infrastructure and gathered useful GIS data to create a GIS database for the project
- Created maps of government sites in Atlanta and their corresponding survey data
- Designed fiber route to connect desired sites to existing fiber infrastructure

PRIOR TO JOINING CTC IN 2015
2015 Potomac RiverKeepers, *Intern*
Created reference map of the North Fork of the Shenandoah River

EDUCATION
Bachelor of Science, Geographic Science, James Madison University, 2015
Dual concentration in Applied Geographic Information Science (AGIS) and Environmental Conservation, Sustainability, and Development (ECSD)

ESRI Training Courses

- Learning ArcGIS Desktop 2014

Software Skills

- Adobe Illustrator
- AutoCAD
- ESRI ArcGIS
- Google Earth
- GPS Pathfinder Office
- OSPInSight
- Remote sensing software

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 complete 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.

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

Commonwealth of Kentucky

- Generated backbone fiber route based on field survey and Commonwealth priorities
- Estimated construction costs and schedule for statewide network
- Generated multiple "what-if" scenarios given ranges of funding
- Identified best-suited strategic partnerships with utility companies and incumbent providers, based on preponderance of fiber routing and community anchor institutions in various utility service areas

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

Anne Arundel County, Maryland

- Performed OTDR and power meter testing for fiber acceptance

PRIOR TO COMING TO CTC IN 2011

2010 James Madison University, *Research Assistant*
2009 Virginia Department of Game and Inland Fisheries, *Extern*

EDUCATION

Bachelor of Science, Geographic Science, James Madison University, 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

Mitchell Hergett | Senior Engineer

Mitch Hergett serves as CTC's on-site liaison to the Montgomery County FiberNet manager and as the primary point of contact between FiberNet and CTC. At the FiberNet manager's direction, Mr. Hergett spends up to 20 hours per week at the FiberNet offices, supporting the FiberNet team on a range of significant short- and long-term design and planning engagements.

At CTC, Mr. Hergett's work involves project management and engineering analysis for public sector clients. He is an experienced communications engineer who assists in the evaluation of broadband (video, voice, and data) telecommunications networks and analysis of broadband technology. He also provides specialized assistance in the design of broadband networks for institutional uses.

Mr. Hergett manages the CTC outside plant engineering team on various engineering projects (e.g., Holly Springs, NC; Westminster and Anne Arundel County, MD); he provides project oversight to ensure that the OSP engineers are complying with project standards, meeting project timelines and he provides the engineers with essential project information. Mr. Hergett performs quality control on the engineering work product, and coordinates with permitting agencies and subcontractors.

Mr. Hergett currently provides project management services and engineering support for Anne Arundel County's department of technology. He works closely with County staff to ensure projects are designed to meet the County's requirements and that they are constructed within acceptable budget and timeline. His tasks include:

- Developing scopes of work for engineering and construction vendors
- Assisting in the RFP creation process
- Tracking changes and additions to County network and overseeing the completion of as-built documentation
- Meeting with project stakeholders and vendors to discuss project status and issues

He provided program-level support and project management for the $115 million statewide One Maryland Broadband Network (OMBN) project. In this role, he assisted stakeholder jurisdictions with program compliance, stakeholder relations, budget management, and contractor management. His tasks include:

- Developing scopes of work for engineering and construction vendors
- Tracking and reporting on compliance metrics
- Documenting program scope changes
- Assisting in the RFP creation process
- Creating materials specifications
- Meeting with project stakeholders to discuss project status, governance matters, and network architecture issues
- Resolving conflicts with Pepco, Verizon, State Highway Administration, and other entities

Mr. Hergett also supports the National Capitol Region (NCR) interoperable public safety communications network, which interconnects 19 jurisdictions around and including Washington, D.C. He has created process engineering deliverables including a detailed satellite phone user manual; a testing procedure to ensure equipment functionality and operator competence for multi-jurisdictional emergency satellite phone calls; and a detailed analysis of discrepancies between the processes presented and processes actually used by the network's service-level agreement (SLA) maintenance vendor. Mr. Hergett also oversees the network's video teleconference (VTC) training course and budget, and provides Tier 1 technical support for the VTC systems.

In a previous engineering role at a major hospital in Montana, Mr. Hergett:

- Developed workflow to help the hospital transition to an electronic health record system
- Created visual diagram detailing information flow to enable prototyping of a new system
- Gathered system requirements from hospital departments and individual users
- Assessed the capabilities and constraints of the new system's software
- Created training manuals for employees to better acclimate to the new system
- Presented to CFO the recommended improvements for the new system's implementation
- Calculated potential savings of the new system at $250,000 a year

PRIOR TO COMING TO CTC IN 2010

2009–2010 Strosniders Hardware, Silver Spring, MD
2009 U.S. Department of Commerce Census Bureau, Silver Spring, MD
2007–2008 Bozeman Deaconess Hospital, Process Engineer Intern, Bozeman, MT

EDUCATION

Bachelor of Science, Industrial Engineering**,** Montana State University, 2008

COMPUTER SKILLS

- AutoCAD
- MasterCam
- Arena
- C++
- Java

CERTIFICATIONS/MEMBERSHIPS

- Institute of Industrial Engineers, Professional Member (2010–present)
- Institute of Electrical and Electronics Engineers, Professional Member (2008–present)

James Jordan | Principal Outside Plant Engineer

Jim Jordan has more than 30 years of telecommunications industry experience in outside plant design, planning, permitting, construction, and quality assurance. He supports a number of regional and statewide network initiatives, including the 800-mile Maryland Inter-County Broadband Network; the ConnectArlington network in Arlington County, Virginia; and the NCRnet network interconnecting the governmental networks in the National Capital Region. In his capacity at CTC, Mr. Jordan:

- Develops design standards for municipal middle-mile and last-mile deployment
- Leads field design work and assessment of existing outside plant infrastructure
- Oversees construction of ConnectArlington middle-mile fiber network
- Tests and validates FTTP and middle-mile fiber in Maryland Inter-County Broadband Network (ICBN)
- Assists in evaluation and selection of construction contractors

Previous to joining CTC, Jim served as an outside plant engineer, cable splicer, and various other positions in the telecommunications industry at Verizon Communications. He was also instrumental in the FiOS fiber-to-the-premises deployment across Maryland and fiber-to-the-cell wireless roll-outs throughout Maryland and Washington, D.C. As a splicer, Jim used the latest splicing and testing methods for copper and fiber. As an Outside Plant Engineer at Verizon, Mr. Jordan:

- Developed design standards for regional FiOS deployment
- Worked with building owners and managers for FiOS overlay deployment
- Performed network engineering at Patuxent Naval Air Station and Joint Base Andrews
- Designed construction of cables and fibers to develop handoff between Verizon and Naval Air Systems Command (NAVAIR)
- FiOS development in Annapolis area for numerous senior living facilities. Designed routing and individual fiber drops for individual dwelling units in compatibility with building architecture
- Oversaw installation of network equipment at federal government sites, including copper and fiber rack facilities in highly secure military facilities and at the U.S. Census Bureau
- Worked in conjunction with U.S. Secret Service personnel on communications for two Presidential Inaugurations under top secret security clearance
- Designed outside plant copper and fiber
- Southern Maryland Engineer for all digital loop carrier systems including Lucent SLC 96, Series 5 and Litespan.
    - Designed repeaters in digital carrier systems network systems

    - Installed copper plant systems, including load coils, lattice networks, and repeater placement
    - Integrated fiber multiplexing devices.
    - Replaced copper link components with fiber
- Installed, tested and maintained wide range of communication systems, equipment, and services: both copper and fiber
- Skilled cable splicer: both copper and fiber
- Served as lead trainer and designer for FiOS deployment at apartment buildings, shopping centers, and office complexes

PRIOR TO COMING TO CTC IN 2013

1979 – 2010 **Verizon Communications**
Outside Plant Engineer

EDUCATION

Postgraduate Work, Business Administration, Liberty University
Bachelor of Arts, Music Education, Bridgewater College

Ziggy Rivkin-Fish | Principal Analyst and Governance Specialist

Ziggy Rivkin-Fish has been an analyst and project manager with CTC since 2005. Mr. Rivkin-Fish has managed multiple federal-grant-funded interoperability projects that interconnect jurisdictional communication networks, including the recent Public Safety Communications Gap Analysis for the Baltimore UASI. He has also applied his management, technical, and governance expertise to the implementation of large-scale network infrastructures.

Mr. Rivkin-Fish has also played key roles in other large-scale projects, such as by overseeing the preparation of successful Environmental Assessments (EA) for major BTOP-funded networks including the One Maryland Broadband Network (OMBN) and the Urbana-Champaign Big Broadband (UC2B) fiber optic network, enabling the projects to proceed to the construction phase. Mr. Rivkin-Fish then oversaw the preparation of required addenda to the OMBN and UC2B EAs to address project revisions during the construction phase. In addition, Mr. Rivkin-Fish advised on the preparation of an EA for the State of Maryland Department of Natural Resources to enable the construction of a radar support tower on state land.

Notably, Mr. Rivkin-Fish has served as the lead manager for all phases of deployment of NCRnet, the interoperable public safety communications network that interconnects 20 jurisdictions in the National Capital Region around Washington, D.C. Mr. Rivkin-Fish's role with NCRnet includes oversight of fiber optic design, procurement, and implementation to network design, governance development, construction oversight, network operations, and long-term sustainment. Mr. Rivkin-Fish has also ensured project compliance with grant regulations, including environmental and procurement requirements.

Mr. Rivkin-Fish's recent accomplishments include a full fiber optic network feasibility study, including a governance roadmap for the city of Highland Park, IL. This study will enable the city to decide between ownership models and methods of operational governance.

In 2015, Mr. Rivkin-Fish completed all requirements and passed the examination for the Certificate in Governance of IT, which will provide him with the final credentials to serve as an organizational management consultant and advise on options for reorganizing and streamlining IT departments and services, a role he has already filled for Harford County, MD.

EDUCATION
Master of Science, Sociology, Princeton University, 2000
Bachelor of Arts, Individualized Major in Social Theory, Rutgers University (4.0 GPA)

HONORS
Norman C. Miller Award for Highest Academic Achievement, Rutgers University, 1995

SELECTED PUBLICATIONS
"NCRnet: How the National Capital Region is Building a 21st Century Regional Public Safety Communications Network" *NATOA Journal* 15(4):16-18. 2007.

Richard "Rook" Rogers | Project Manager

Rook Rogers is an experienced project manager and problem solver who has overseen successful statewide and regional network construction projects, developed processes and frameworks for enabling complex organizational requirements, and served as Chief of Staff to the County Executive of Anne Arundel County.

Rook manages CTC's ongoing outside plant (OSP) fiber design and engineering engagements with Anne Arundel and Prince George's counties and the City of Westminster. As CTC's designated point of contact for Montgomery County, Rook will ensure that every request for technical support is quickly addressed, that project plans are established, and that the County receives high-quality and responsive support from CTC staff.

Rook previously served as the Special Projects manager for the Maryland Inter-County Broadband Network (ICBN) project. His responsibilities in that role included overseeing and managing the project's aerial attachment agreements with pole owners and expediting the roadblocks that hindered the completion of the project, including issues that arose with the State Highway Administration, Pepco, Baltimore Gas and Electric, Verizon, the Army Corp of Engineers, and several cable communications companies. Rook also managed the ICBN QA/QC program and was the ICBN Project Manager for the City of Baltimore.

Over the past 38 years, Rook has held executive positions such as President, Vice President, and CEO/Partner for corporations and government administrations. His rise to the corporate level has been due to dedication and hard work, paired with the ability to manage people, create a positive work environment, and ensure cohesiveness within an office.

PRIOR TO JOINING CTC IN 2015

2014 **Anne Arundel County Government**, *Chief of Staff*

- Handled day-to-day functions of County Executive's Office and Constituent Services
- Managed $1.5M office budget and decision-making process for $1.2B county budget

2012 – 2014 **E-Landscape Specialty Solutions**, commercial landscape firm, *CEO/Partner*

2010 – 2012 ***Independent Consultant in project management***

- Directed the construction build out of the Inter-County Broadband Network Fiber Optic Program in Central Maryland
- Managed utility companies, State Highway Administration issues, Railroad issues and managed the build out of the Baltimore City fiber optic installation
- Worked with management team, construction contractors and nine jurisdictions to complete the build-out on time

1976 – 2010 **McKinney Drilling Company**, *Vice President of Southeast Region, President*

- 2006-2010 served as Vice President of Southeast Region
- 1976-2006 worked for subsidiary Seaboard Foundation, rising from laborer to president, served as President 1984-2003

EDUCATION

Anne Arundel Community College
Tusculum College, 1974

COMMUNITY SERVICE

- Sandy Spring Bank, Advisory Board Member
- Anne Arundel Medical Center Foundation, Co-Chairman of Fundraising
- OS Charitable Trust, Trustee
- United States Naval Academy, Sponsor Parent
- St. Mary's School, Volunteer Coach, also served on several committees

Shawn Thompson | Principal Engineer and Wireless Networking SME

Shawn Thompson is a recognized expert in indoor wireless engineering and radio propagation. He has overseen the design and implementation of more than 1,000 distributed antenna systems nationwide, and has advised wireless carriers such as Sprint, Verizon, and AT&T in solving their indoor coverage and capacity needs. He has also built engineering teams domestically and in Brazil, and sits on the Technical Advisory Board for Corning MobileAccess.

Mr. Thompson is a technically skilled businessman with a proven track record and a versatile skill set developed through 10 years' experience as the founder and CEO of a technology company.

Among his recent client engagements, Mr. Thompson led the CTC team that designed a neutral-host distributed antenna system (DAS) network to enable the government of the **District of Columbia** to use its citywide fiber to distribute wireless signals. He then worked with the District to develop a program for installing commercial, public safety, and Wi-Fi wireless systems in its key facilities. This $10 million, five-year program will improve wireless communications in as many as 60 city-owned buildings.

Additionally, Mr. Thompson assisted the District in developing a strategy for the use of small-cell technology, in which cellular carriers use poles and rooftops owned by municipalities to increase the density of their high-speed 4G LTE networks and deliver better service. This sector promises to be a growth area, as more and more carriers approach municipalities to negotiate terms of usage. Mr. Thompson helped the District move to the forefront of cellular deployment technology by developing a plan for standardizing equipment and space utilization for hundreds of proposed tower sites. Mr. Thompson's plan will allow the city to maximize profits, reuse sites efficiently, and maintain sites more easily. His work will also benefit the area's cellular carriers and citizens by paving the way for streamlined cooperation between the municipal government and the carriers to maximize tower deployments and create denser coverage.

Mr. Thompson is providing strategic and technical guidance to the **City of San Antonio's Aviation Department** on the design of a neutral host DAS and Wi-Fi implementation in the San Antonio International Airport. He has conducted a high-level analysis of strengths and weaknesses (particularly with regard to public safety communications), prepared technical questions focused on gaps and other issues identified during his review of the airport's existing environment, and conducted a detailed project review.

Mr. Thompson helped the **City of Boulder, Colorado** evaluate technical and operational options for deploying an outdoor Wi-Fi network in the downtown area. His goals in that engagement were to ensure that the Wi-Fi design and components:

- Enable roaming between the outdoor areas and nearby governmental buildings
- Provide public Wi-Fi connectivity within a defined downtown area

- Are interoperable with the City's existing infrastructure and current processes
- Are scalable for future outdoor Wi-Fi expansion

And in **Garrett County, Maryland**, Mr. Thompson designed a planned TV White Spaces (TVWS) solution for broadband service to rural unserved areas, including RF models and spectrum planning.

Technical Background

Indoor Propagation Theory

Mr. Thompson was an early pioneer (2003-2005) in educating the industry against the use of coffee cup design (i.e., the idea that RF travels a uniform distance from a radiating point). Rather the partitions within buildings greatly affect the propagation patterns, and therefore RF power levels, antenna types, and intended density need to be considered in each building.

He collected data from multiple types of indoor environments to improve the published equations for indoor RF propagation. Specifically, he has made improvements to modeling RF propagation in environments such as industrial, retail, hospital, and airport venues.

Mr. Thompson has also furthered the understanding of antenna density and types within different types of environments. He has shown that the typical omni-directional antenna may not be appropriate for many newer high-capacity wireless systems. Mr. Thompson has demonstrated through various stadium designs that precisely controlling the antenna beam-width patterns can have dramatic impact on throughput because of the antennas' sensitivity to noise and unwanted signals.

High-Capacity Design

Mr. Thompson has developed solutions for the ever-growing capacity needs in public venues such as stadiums, arenas, and airports. Working with manufacturers and carriers, he has participated in developing solutions that deliver high-speed data to users in these ultra-dense environments. In particular, Mr. Thompson's innovative sector-driven design approach using distributed antenna systems is driving a complete revamping of the existing systems in stadiums across the country. Among the stadiums on which Mr. Thompson has worked are First Energy Stadium and Progressive Field in Cleveland; PNC Park in Pittsburgh; the Verizon Center in Washington, D.C.; and stadiums at the University of Montana and the University of Wyoming.

Program/Project Management

As an early leader in distributed antenna system design, Mr. Thompson has collaborated with industry groups, wireless carriers, and manufacturers to develop several industry best practices. He assisted industry manufacturers in developing a grounding methodology that could be used

as a template for the installation of DAS systems. The solution needed to be vetted and agreed upon by installation contractors, manufacturers, and carriers.

In 2012, working with Verizon Wireless on LTE DAS upgrades, Mr. Thompson developed a system through which Verizon could easily collect information across a region (usually several states) at existing sites, to determine a rough order of magnitude to upgrade these sites with 4G LTE service. This was executed in blocks of 100 projects. Also in 2012, he developed methodologies to use "The Last Planner" project management system across large DAS deployments.

Most recently, Mr. Thompson contributed to the understanding and practicality of passive intermodulation (PIM) testing within low-power RF antenna systems. Mr. Thompson successfully negotiated compromise between construction-side concerns and carrier-demanded closeout policies by assembling leaders across various disciplines, resulting in a white paper outlining a compromise for all parties.

EMPLOYMENT HISTORY

Henkels & McCoy 2011 – 2013

Associate Director, Wireless Solutions

- Managed profit and loss of $18 million wireless division
- Responsible for doubling revenue from $9 million in FY12 to $18 million in FY13
- Oversaw several major wireless projects, such as NFL and MLB stadiums

Manager, Engineering and Design

- Directed the development of an effective team of qualified RF engineers, engineering assistants, and engineering managers in accordance with the business plan's budget and staffing goals
- Acted as senior technical resource for the company-wide wireless business

In-Building-Wireless, *Co-Founder and CEO* 2004 – 2011

- Named to 2007 and 2008 *Inc. Magazine* list of fastest growing private companies
- Developed and executed all facets of the core business plan and marketing plan that led to 100 percent growth year-over-year from 2004 to 2007
- Developed the firm's project management process and best practices
- Orchestrated acquisition of In-Building-Wireless by Henkels & McCoy

Applied Communications Technology, Inc., *Founder and President* 1999–2004

- Initiated government sales efforts and built $2 million in volume in 3 years
- Developed proprietary project management software

EDUCATION

Bachelor of Science, Mechanical Engineering, University of Maryland, 1990–1993

PROFESSIONAL CERTIFICATION

- BICSI
- Corning MobileAccess
- Anritsu, Spectrum Analyzers

Eric Wirth | Senior Fiber and Wireless Project Engineer

Eric Wirth has more than 10 years of communications engineering experience; he specializes in evaluating broadband (video, voice, and data) telecommunications networks, analyzing emerging technologies, and designing broadband networks for institutional uses. In addition, Mr. Wirth is central to the network implementation of for Internet Protocol (IP) applications, including video-over-IP (VoIP) for video transmission over wide area networks, video conferencing, and other communication applications for metropolitan area and wide area networks.

Utility and Public Safety Fiber Optic Networking

Mr. Wirth's experience includes the design and implementation of a variety of fiber optic communications network. Some select examples of his work include:

- Developing a fiber optic network to connect a variety of sites for the **City of Atlanta**. The network will connect traffic signals, police cameras, and City facilities. The City is also looking to expand the network to support other government partners. Mr. Wirth is developing a network design to support both new fiber optic routes and to utilize existing fiber routes where fiber optic strands are limited.
- Design and pricing of fiber optic cable, electronics, and overall architecture of a survivable emergency communications system for **Tennessee Valley Public Power Association** (TVPPA) distributors. The design included MPLS and DWDM technology.
- Design and implementation of a fiber optic network for **Norwich (Connecticut) Public Utilities**. The project consisted of developing detailed fiber optic route design and cost estimates, network electronic design and cost estimates (including SCADA transportation), and a request for proposals (RFP) for Norwich's use in selecting a contractor to complete the installation. In addition to serving the utility's needs, the fiber optic network was designed to serve city, schools, and hospital users.
- Fiber-to-the-premises high-level design and cost estimate for the **Lexington-Fayette Urban County Government in Kentucky**. Mr. Wirth developed a fiber optic and network electronics design to serve the entire city of Lexington and provide the City with a cost estimate to use in negotiations with a network service provider.
- Fiber optic network design and feasibility analysis for the **City of Palo Alto, California**. The City is examining several fiber optic construction projects to expand its existing fiber optic network to meet the needs of the city, the municipal electric utility, and surrounding school districts, and to increase the footprint of its commercial fiber optic network.

- Fiber optic network design, RFP development, and construction oversight for **Leisure World of Maryland**. Mr. Wirth developed a fiber optic network and electronics design to connect all of the Leisure World facilities to allow the consolidation of Leisure World's data and voice networks. After developing a design and cost estimate, Mr. Wirth wrote an RFP for fiber construction, helped choose a fiber optic construction contractor, and oversaw the fiber optic construction.

Wireless Communications

Mr. Wirth has extensive experience working on numerous wireless networking projects, from analysis and feasibility to design and implementation. These networks range in scope from small hot spots to area-wide and regional networks. Some representative examples of his projects include:

- Designing and overseeing the implementation of a citywide broadband wireless network project that will provide integrated communications and interoperability among all local public safety entities in the **City of Port Angeles, Washington**. The high-capacity 4.9 GHz broadband wireless network provides public safety staff in the field with full and timely access to state, federal, and GIS databases, and will allow EMS responders to access medical databases and support on-site telemetry of patient status. A commercial "open access" multi-provider wireless access system was deployed as a public–private partnership with a local Internet service provider (ISP); it provides citywide WiFi services in the 2.4 GHz band.

- Designing a cost-effective broadband wireless network for the **City of Annapolis, Maryland**. This network serves as a backbone to provide connectivity for a video surveillance system throughout downtown Annapolis. The network has the capacity to meet all current needs, provide 99.999 percent availability, and have substantial reserve capacity to support the addition of new video requirements, expanded IP-based voice and data services, and support backhaul for a potential mobile wireless solution.

- Acting as lead engineer for the design and implementation of a microwave network to enable communications between public health agencies in Maryland and the District.

Public Safety Networking

Some representative examples of Mr. Wirth's projects include:

- Designed, implemented and tested a backhaul network for the **Arlington County, Virginia** public safety radio network. The backhaul network consists of SONET equipment over a county-owned fiber optic network that increases the reliability and availability of the public safety radio system.

- Lead engineer for the design and implementation of a 19-jurisdiction regional fiber optic public safety interconnection network in the **National Capital Region** (DC, MD, VA). NCRnet provides an interoperable, robust, and reliable fiber infrastructure to augment the communication capabilities of first responder communities in the NCR. These

communities include local and regional law enforcement, fire, emergency management, transportation, and public health agencies.

- Performed radio frequency (RF) coverage analysis and prepared design recommendations for improving public safety radio coverage for **Warren County, Pennsylvania**. Included analysis of the county's existing public safety radio system and recommendations to improve coverage for public safety radio and commercial cellular.
- Collaborated on the development of a master telecommunications plan for the **Delaware Department of Transportation**. The plan acts as a guide for the department to consolidate several disparate network environments into a unified communications network capable of supporting current and future transportation and public safety applications. Part of the plan involves developing a system-level design that incorporates fiber optics, microwave, and land-mobile radio. The plan requires coordination among a variety of state agencies.

Video and Broadcast Communications Engineering

Mr. Wirth's experience includes the design and implementation of video, voice, and data networks. Some select examples of his work include:

- Designed and implemented a public, educational, and governmental (PEG) access and monitoring network for **Montgomery County, Maryland**. The network uses IP-based video encoders and the County's state-of-the-art IT network to improve the quality and functionality of video transport throughout the county.
- Developed a design and integration solution for cablecast channels for **Monterey County, California**. Analyzed the existing audio-visual and broadcast systems and developed recommendations for future development. Designed an IP-based video server system capable of recording and airing live meetings and scheduling cable/broadcasts. Completed on-site integration, testing, and training on the video server system.
- Designed and implemented state-of-the-art videoconferencing and teleconferencing tools for the 19 jurisdictions in the **National Capital Region** Emergency Operations Centers (EOCs) and Emergency Communications Centers (ECCs). CTC developed the systems' designs and oversaw implementation to interconnect the EOCs and ECCs throughout the region, under a grant from the U.S. Department of Homeland Security Urban Areas Security Initiative (UASI).

PRIOR TO COMING TO CTC IN 2004

1998 – 2003 Schnabel Engineering, Inc., *Technician*, Baltimore, MD

EDUCATION

Bachelor of Science, Electrical Engineering**,** University of Virginia School of Engineering and Applied Science, Charlottesville, VA, 2004

Jim Zimmermann, PMP | Principal Engineer

Jim Zimmermann is an experienced project manager and engineer with almost 20 years of experience as a network systems engineer. He supports local and state government clients on complex project-management and network-engineering engagements. His expertise covers a wide range of network and project-management skill sets, including:

- Unified Communications and Network Systems Engineer/Project and Program Manager
- Complex solution delivery to Enterprise, Agency, Telecom/Cable/Wireless providers
- Engineering, operations, management, and business development
- Life-Cycle Systems Engineering; CONOPS, use-case development, requirements definition and traceability, architecture, design, change and configuration management, integration/service deployment, network and performance management

Technical Domain

Engineering

- Unified Communications
- Multi-vendor, open-standard, SIP based architectures
- LAN, WAN, Backhaul Networks
- QoS—DIFFSERV, 802.1p/q, MPLS
- Traffic and capacity engineering
- Mobility, 4G/LTE, 802.11x Wi-Fi, HS 2.0
- Networking—Access, Distribution, Core
- Network Security, AAA, IDS/IPS, SBC
- Data Center Engineering
- OOB/remote access, virtualization, storage
- Infrastructure, cabinets, power, cabling
- Relational Database design/development**,** SQL, VBA

Operations

- NOC & Call Center setup and management
- FCAPS/ITIL Methods & Processes
- Planned and unplanned Event Management
- Stakeholder Communication/Escalation plans
- Application Performance Management
- Service Level Management
- Staffing, Job Descriptions, Hiring, Training
- COOP and BC/DR planning
- Subscriber and device provisioning
- Device Management
- Management Reports and Analysis
- Acceptance Test Plans/Operational Readiness

PRIOR TO JOINING CTC IN 2014

LGS Innovations/Bell-Labs Professional Services, Herndon, VA 2007 – 2014
(LGS is a wholly-owned subsidiary of Alcatel-Lucent)

Senior Systems Engineer/LGS Operations and Special Projects 2011 – 2014

- Oversaw Unified Communications architecture and design, wrote technical response to government RFPs
- Provided pre-sales solution engineering for Mobility, UC, BYOD, Device Management, Virtualization, Cloud
- Established contractor recruiting processes for high volume Intelligence Community contracts. Developed recruiting applications to streamline candidate interviews, resource/requirement matching, and resume template submission
- Conducted 100+ technical interviews for software development contract

Senior Program Manager/Senior Network Systems Engineer 2011 – 2012

- Planned and Implemented a Multi-Tenant 4G/LTE Core (ePC) and RAN pilot (Band-14/pre FirstNet)
- Navigated complex regulatory (FCC, PSST, FAA) processes, secured state-level concurrence for spectrum use
- Integrated LTE access into fixed and mobile Wi-Fi, SIP voice / video / conferencing, and Land Mobile Radio
- Demonstrated capabilities and benefits of LTE to state and local jurisdictions (law enforcement, fire, medical, civil defense), and to federal stakeholders and pilot participants
- Developed LGS architecture & business model for multi-tenant Public Safety LTE-as-a-Service
- Upgraded customer network to provide QoS over redundant (Gigabit and Microwave) IP/MPLS backhaul

Senior Program Manager/Senior Network Systems Engineer 2010 – 2011

- Managed Engineering, Operations, and Deployment project teams on cloud UC project.
- Engineering: Designed and managed core systems and software. Tested and evaluated third-party systems for device management, provisioning, fault and performance management, and session border control. Migrated production core systems from Solaris to Red Hat. Developed installation packages and operational readiness & acceptance test plans.
- Deployment: Developed and streamlined processes for site surveys; PSTN access, feature use & configuration, dialing & numbering plans, circuit migration/number porting. Performed local installation, integration, end user training.
- Operations: Tiered support processes, FCAPS monitoring, event-management, ticketing, communication and escalation plans, operational reporting, continuous

process improvement.

Senior Network Systems Engineer 2009

- Designed and implemented End-to-End IP Network QoS Architecture for agency-wide network convergence
- Refined agency/site level migration strategies, transition plans, and operational readiness test plans to successfully deploy cloud-based UC architecture to 300+ field offices, approximately 30,000 lines.

Senior Network Systems Engineer 2008
Transformational Satellite Program, System Interface Control and Risk Management

- Established requirements traceability and risk management matrices to support PDR and CDR

Senior Program Manager/Senior Network Systems Engineer 2007 – 2008

- Designed and deployed carrier class VoIP solution to agency customer through FOA and SOA
- Delivered Geo-Redundant call control, Integrated Messaging, Number and Dialing Plans, Route Redundancies, Toll- bypass, Least Cost Routing, LD aggregation, Local Survivability, COG, BC/DR, Operational Support Systems
- Drove significant economies for agency through consolidated PSTN access, improved end-user capabilities and productivity, and operational efficiencies of a cloud-based UC architecture.

Lucent Technologies, Professional Services (Federal), Herndon, VA 2003 – 2006

Technical PM / Senior Network Systems Engineer 2005 – 2006

- Ran extended SIP/UC trial, demonstrated integration of cloud-based UC with legacy TDM/PBX systems
- Demonstrated the power and flexibility of cloud-based UC for COOP in post-Katrina markets

Technical PM/Senior Network Systems Engineer 2004 – 2005

- Managed simultaneous delivery of two VoIP trials – Lucent 5E/iMerge and BroadSoft

Senior Network Systems Engineer 2003 – 2005

- Supported multiple programs and initiatives, Columbia, MD

Lucent Technologies, Professional Services (Commercial) 2000 – 2003
(Lucent acquired previous employer, INS)

Technical PM/Senior Network Systems Engineer 2001 – 2003

Client: Nextel Communications, Reston, VA

Scope: Nationwide Mobile-IP System upgrades, features and capacity, and CALEA deployment and integration

Manager IP Services & Architecture Engineering/Senior Network Systems Engineer 2001
Client: Winstar Communications (Fixed Wireless CLEC & ISP)
Scope: Re-Design, Build, Operate, Transfer – Web Hosting Centers

Technical PM/Senior Network Systems Engineer 2000
Client: Nextel Communications, Reston, VA
Scope: Nationwide Deployment and Integration of Mobile IP into Nextel Mobile Switch Offices (MSO's)

International Network Services (INS), Sunnyvale, CA 1998 – 2000
(INS was a global Professional Services Partner for Cisco Systems)

NOC Manager/Senior Network Systems Engineer 1999 – 2000
Client: Roadrunner High-Speed Online Cable ISP, Herndon, VA
Scope: Build, Staff, Operate, Transfer National NOC, replaced regional NOCs run by Cable Affiliates

Network Systems Engineer/PM 1998 – 1999
Client: AT&T Wireless Regional Partner (Telecorp, Inc.), Arlington, VA
Scope: Build, Operate, Transfer LAN/WAN, Data Centers, Security for HQ and 5 Regional MSO's and retail store

EDUCATION

Computer Science and Network Engineering—Bucks County College, Newtown, PA
Bachelor of Science, Chemistry, Syracuse University, Syracuse NY

PROFESSIONAL CERTIFICATIONS, TRAINING, AFFILIATIONS

- PMP Cert #1570166 (2012)
- ITIL Foundations v3 (2010)
- PDMA Product Dev and Management Association
- BroadSoft Basic Sys Admin
- BroadSoft Adv Sys Admin
- Juniper Basic Networking
  Juniper Adv Networking
- Cisco Basic Networking
- Cisco Advanced Networking
- Cisco Security Architectures
- LU Mgmt and Leadership
- LU Program Management
- LU Springtide (Multi-Service)
- LU PSAX (ATM)
- LU Tactical Wireless
- LU Stinger (DSLAM)
- ALU 4g/LTE Backhaul
- ALU 4G/LTE eNode-B
- ALU 4G/RAN, RF Systems
- ALU 4G/LTE ePC (MME, PCRF, SGW/PGW)