**National Telecommunications and Information Administration**

Broadband Technology Opportunities Program Evaluation Study

Order Number D10PD18645

**Case Study Report**

**Merit Network, Inc.**

**Comprehensive Community Infrastructure**

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# Executive Summary

## About BTOP

The American Recovery and Reinvestment Act of 2009 (Recovery Act) appropriated $4.4 billion in federal funding to the National Telecommunications and Information Administration (NTIA) to implement the Broadband Technology Opportunities Program (BTOP) in order to spur job creation, stimulate economic growth, and increase access to broadband services.[1] BTOP projects are intended to support increased broadband access and adoption, provide broadband training and support through community organizations, and stimulate the demand for broadband. NTIA distributed grant funding to 233 projects, benefiting all 50 states, 5 territories, and the District of Columbia. The types of projects BTOP funded include Public Computer Centers (PCC), Sustainable Broadband Adoption (SBA), and Comprehensive Community Infrastructure (CCI). CCI projects deploy new or improved broadband Internet facilities to connect households, businesses, and community anchor institutions (CAI) such as schools, libraries, hospitals, and public safety facilities.[2] CCI projects funded by BTOP are predominantly middle mile projects, although a small number of last mile projects were awarded.[3]

> Comprehensive Community Infrastructure projects deploy new or improved broadband Internet facilities to connect households, businesses, and community anchor institutions such as schools, libraries, hospitals, and public safety facilities.

## About the Evaluation Study

This case study report is one of twelve case studies performed by ASR Analytics, LLC (ASR) on CCI projects. It is part of a larger mixed-methods evaluation of the social and economic impacts of the BTOP program.

The purpose of this case study is to:[4]

- Identify how the grantee maximized the impact of the BTOP investment.
- Identify successful techniques, tools, materials, and strategies used to implement the project.
- Identify any best practices, and gather evidence from third parties, such as consumers and anchor institutions, as to the impact of the project in the community.

> The information presented in this report intends to capture the social and economic impacts of the grant, and is not an evaluation of Merit, its partners, or its project participants.

This case study is primarily qualitative. Social and economic impacts are categorized by the five focus areas described in *Interim Report 1*, with the addition of the Government Services focus area.[5] Section 2 includes the presentation of these impacts by focus area.

The evaluation study team collected information to evaluate the social and economic impact of the Merit Network, Inc. (Merit) project during field visits. From September 16 to 20, 2013, the evaluation study team met with representatives of Merit and CAIs connected by the project. In total, the evaluation study team performed fifteen site visit interviews and focus groups. ASR transcribed these discussions and used this information, along with other information and reports provided by the grantee, to supplement Quarterly Performance Progress Reports (PPR), Annual Performance Progress Reports (APR), and other publicly available information. The information presented here

intends to capture the social and economic impacts of the grant, and is not an evaluation of Merit, its partners, or its project participants.

## About the Grantee

Merit Network Inc. (Merit) is a nonprofit broadband service provider. For the past forty-seven years, Merit has built and run networks for education and nonprofit anchor institutions throughout the State of Michigan. It helped build the National Science Foundation Network (NSFNET) in partnership with MCI and IBM, a precursor of today's Internet. Merit's mission is to be a respected leader in developing and providing advanced networking services to the research and education community. Merit is a trusted source for providing high-quality network infrastructure; initiating and facilitating collaboration; and providing knowledge and technology transfer through outreach.[6] In addition to providing broadband service, Merit provides hosted applications and hosted infrastructure, including e-mail, voice, storage, and virtual servers. Merit Network members benefit from Merit's engineering expertise through IT consulting support, IT seminars and training classes, and negotiated discounts on software licensing fees for community members. Michigan State University (MSU) uses Merit's network and high definition video to teach remote medical school classes around the state.[7]

Before BTOP, Merit owned and operated a 1,600-mile backbone fiber network in Michigan that delivered speeds of 10 Gbps. On January 15, 2010, NTIA awarded Merit a BTOP CCI grant for $33,289,221 to implement the Rural Education Anchor Community Healthcare Michigan Middle Mile Collaborative (REACH-3MC) project.[8] Merit and three project participants supplied $8,322,305 in matching funds, for a total project budget of $41,611,526.[9] In addition to receiving this Round 1 BTOP grant, Merit also received funding to implement the REACH-3MC II project under Round 2 BTOP funding, which planned to add another 1,172 miles to the network in Michigan's Upper Peninsula, reaching into Wisconsin and Minnesota. This report focuses on the Round 1 grant, although references to the Round 2 grant are discussed.

> The REACH-3MC project invested a total of $41,611,526 in Michigan's Lower Peninsula.

## Project Proposal and Status

Merit planned to deploy a high-speed, fiber-based middle mile network through Michigan's Lower Peninsula to serve institutions directly and increase broadband availability to businesses and households through third-party providers. The Merit project proposed the following, with results shown:[10]

- Construct 955 miles of new fiber in underserved counties in Michigan's Lower Peninsula and directly connect 44 CAIs. At the time of the site visit, Merit had constructed over 1,000 miles of new fiber infrastructure. The grantee reported physically connecting 154 CAIs to the network, of which 55 are directly subscribing to service.[11]

- Foster economic development and growth in underserved areas of Michigan that lack widely available and affordable broadband services. The site visit team spoke with three providers that are now using the REACH-3MC middle mile infrastructure to provide last mile services. These last mile providers reported that the grant improved opportunities for

> Merit accomplished the following from their proposed goals:
>
> - Installed more than 1,000 miles of fiber
> - Improved opportunities for last mile providers
> - Provide service to 55 CAIs at a minimum speed of 3 Mbps
> - Provide additional services to CAIs including voice and video

their businesses and service areas, including opening new markets and the ability to pass along cost savings to customers.

- Offer fiber services and speeds from 1.5 Mbps to 10 Gbps to a service area with more than 932,000 CAIs, households, and businesses. Of the fifty-five CAIs served by Merit, the lowest subscription speed is 3 Mbps. One of the last mile providers that now purchases backhaul through a project participant reported that it has increased minimum speeds offered to customers from 512 kbps to 3 Mbps at no additional cost to consumers. The number of households and business served by last mile providers is not publicly available.

- Collaborate with its participants to offer broadband Internet, voice, and video services to CAIs, households, and businesses. As part of its business strategy, Merit is beginning to offer a wider range of services to CAIs over its network, including hosted applications, hosted infrastructure, and value-added services. Participants are service providers that own strands of fiber on segments of the backbone. Access to the network for project participants and the last mile providers they serve will facilitate similar offerings to households and businesses.

As shown in Table 1, half of the 154 CAIs connected are educational institutions.[12] The grantee originally planned to directly connect forty-four CAIs.[13]

### Table 1. Community Anchor Institutions Located in the Service Area

| Type | Connected by Grantee | | Total in Service Area |
|---|---|---|---|
| School (K-12) | 48 | 31% | 1,135 |
| Library | 18 | 12% | 130 |
| Medical/Healthcare | 12 | 8% | 1,258 |
| Public Safety | 12 | 8% | 476 |
| University, College, or Other Postsecondary | 29 | 19% | 50 |
| Other Community Support | 35 | 23% | 35 |
| All | 154 | | 3,084 |

There is a substantial opportunity to leverage the Merit infrastructure in Michigan's Lower Peninsula beyond the scope of the original set of CAIs proposed in the grant application. The fixed cost of laying the middle mile fiber network has already been incurred, and the marginal cost of connecting more CAIs is the remaining cost driver. Merit staff members reported that they were already beginning to connect additional CAIs that are willing to incur the cost of connecting to the fiber.

## Major Outcomes and Impacts

Through interviews and data collection from a number of sources, the evaluation study team observed qualitative and quantitative outcomes and impacts of the project. The list below highlights these outcomes and impacts, with additional detail provided in Section 2.

- Many CAIs are using the network to increase distance learning opportunities for students. Access to faster upload speeds at lower costs helps community colleges and K-12 schools host online classes and increase class offerings from different institutions.

- The Merit network connects institutions of higher learning and facilitates collaboration by allowing them to freely connect to other institutions on the network, or access on-net services, at speeds up to 1 Gbps. This allows institutions to collaborate on research, and to cut costs by

sharing services, including hosting. Merit provides some content over this network as well, including Internet2. These services give faculty, staff, and students fast and reliable access to educational and research opportunities.

- The network helps students access online learning environments that can aid traditional instruction and help cater to different learning styles. For example, the increased capacity from REACH-3MC has allowed Charlevoix Public Schools to implement a one-to-one iPad initiative.

- The increased middle mile infrastructure has been beneficial for rural Internet Service Providers (ISP), residents, and businesses. Several areas the site visit team visited were beginning to receive residential wireless or fiber services through a last mile provider that had connected to the REACH-3MC network. Many of these areas only had one provider, if any, before BTOP. Both of the ISPs that had been providing service before the network expansion reported being able to offer faster speeds and lower prices to customers, and the wireless provider reported providing services in at least one area where there had been no reliable alternatives.

- The free on-net services provide incentive for CAIs to create wide area networks (WAN) using Merit fiber, as they can have a 1 Gbps network between facilities without paying for bandwidth. This provides cost-savings for any CAI organization with multiple locations. It also streamlines internal communication and allows organizations to operate with greater efficiency.

Through BTOP, the project achieved the following community impacts:

- Improved distance learning opportunities at community colleges and K-12 schools
- Fast and reliable access to educational and research opportunities
- More interactive and engaging K-12 instruction
- Improved competition and prices for CAIs and broadband subscribers
- Improved professional development opportunities for CAI staff

- CAIs are using the increased capacity to access online training for staff. This reduces travel time and expenses, and provides greater opportunity for professional development. As part of its educational mission, Merit provides webinars and outreach for all institutions that subscribe to its broadband service.

## Conclusions

Without the BTOP grant, Merit would have built a similar network, but the grantee estimated the project would have taken fifteen to twenty years to complete. The 154 CAIs served by the grant would not have had access to the 1 Gbps network, and the 55 CAIs that subscribed to service would not be receiving faster bandwidth at a lower cost. Educational institutions would not have been able to implement technology in the classroom or distance learning to the same extent. Project participants would not be building out the network or offering wholesale services to reach residential and business customers, and much of the service area would still have inadequate access to reliable broadband at a reasonable cost. Although pricing data are not available for all interviewees, some of the interviewees reported paying the same

Some community anchor institutions interviewed by the evaluation study team are paying the same price for faster speeds, while some are paying substantially less. All CAIs now have the capacity to use up to 1 Gbps for short periods free of charge.

amount for faster speeds, while some are paying substantially less for the faster service. For example, the University of Michigan Biological Station's speed increased from 3 Mbps to 1 Gbps, and reported paying approximately one-third of the cost. In addition, all CAIs now have the capability to use up to 1 Gbps for short periods free of additional cost.
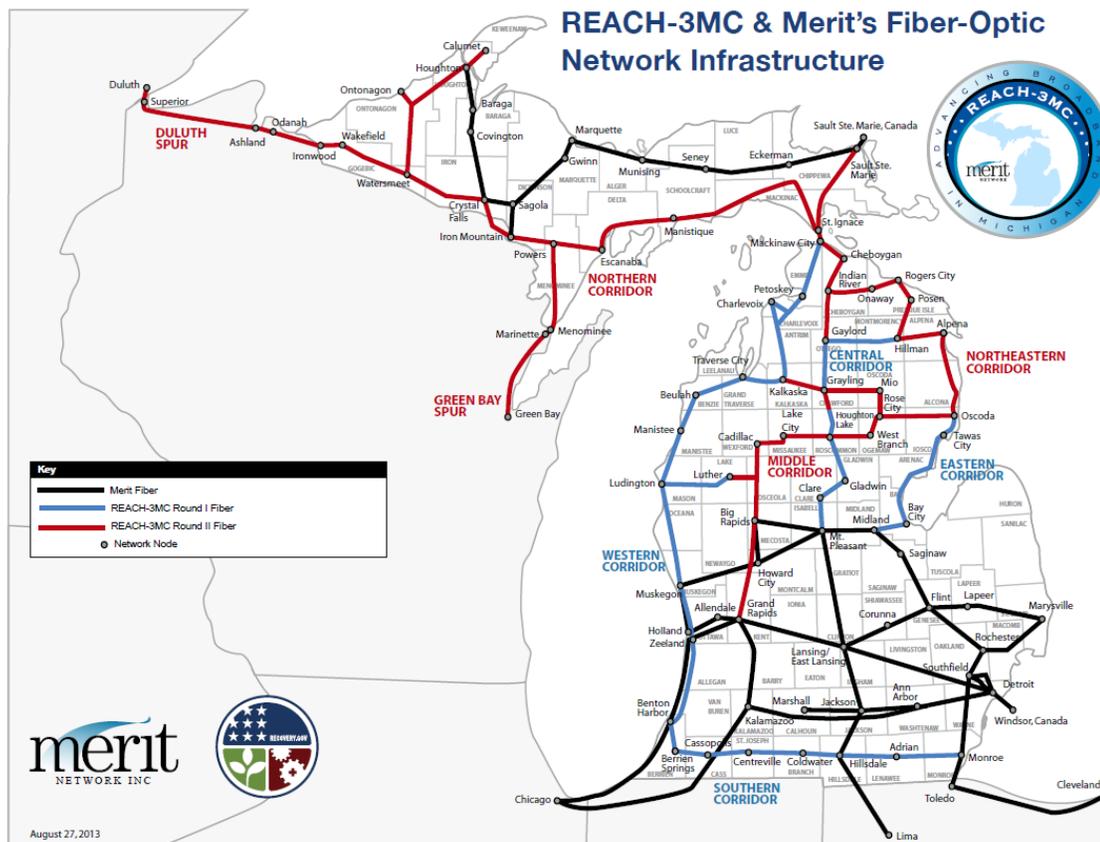
# Section 1. Introduction

The goal of the REACH-3MC network was to directly connect forty-four CAIs in the Lower Peninsula of Michigan, and to make broadband more easily available to service providers and their residential and commercial customers.[14] As a nonprofit entity, Merit's mission is to provide service to CAIs. However, the REACH-3MC network also sought to expand broadband access to residential and commercial subscribers by collaborating with three service providers that own fiber on the middle mile network. At the time of the site visit, these grant participants were expanding use of the network and providing wholesale and last mile service to customers.

Figure 1 shows the entire Merit network, including infrastructure before BTOP and the network expansion built through both rounds of BTOP. This case study report focuses only on the implementation and impacts of the Round 1 grant, shown in blue.

**Figure 1. Merit Network Fiber Route**



Merit proposed a service area of twenty-four counties throughout Michigan: Allegan, Antrim, Arenac, Bay, Benzie, Berrien, Branch, Cass, Charlevoix, Clare, Emmet, Grand Traverse, Hillsdale, Iosco, Isabella, Manistee, Midland, Monroe, Montmorency, Muskegon, Otsego, Ottawa, Roscommon, and St. Joseph. Merit confirmed another eight counties in its final Round 1 service area: Crawford, Gladwin, Kalkaska, Lake, Lenawee, Mason, Oceana, and Van Buren. The evaluation study team also located a CAI in Cheboygan County. Throughout the report, any discussions of the grant's service area refer to the combined thirty-three counties listed above.

This service area is predominantly rural.[15] Thirty-three of Michigan's eighty-three counties fall in the service area (40 percent) but the service area represents just 20 percent of Michigan's total population. The American Community Survey (ACS) Five Year Summary for 2007 to 2011 shows nearly 91 percent of the service area residents are White, compared to 76 percent of the population in the rest of Michigan.[16] More than 54 percent of service area residents have a household income of less than $50,000 per year, compared to 50 percent of the population in the rest of Michigan.[17] A high school diploma or GED is the highest level of education for 47 percent of the service area residents over the age of twenty-five. The same is true for 42 percent of the rest of Michigan's population.[18] Nearly 15 percent of the service area residents are living in poverty.[19] Using publicly available data, the evaluation study team identified 3,084 CAIs in the service area, including 1,135 K-12 schools, 1,250 medical/healthcare facilities, 476 public safety institutions, 130 libraries, and 50 universities, colleges, or other postsecondary institutions.

Table 2 shows the percentages of the populations in the service area and the rest of Michigan by the number of broadband providers available according to data and speed thresholds defined by the National Broadband Map (NBM).[20] A much larger proportion of the service area population does not have access to any broadband providers compared to the rest of Michigan, more than 14 percent versus nearly 7 percent. Twenty-one percent of service area residents have only one broadband provider available, while only one broadband provider is available to 12 percent of residents in the rest of Michigan. All provider statistics use the June 2011 release of the NBM and 2010 population data from GeoLytics.

### Table 2. Number of Broadband Providers Available in Michigan

| Number of Providers | Service Area | Rest of Michigan |
|---|---|---|
| 0 | 14.16% | 6.51% |
| 1 | 20.75% | 12.34% |
| 2 | 40.07% | 31.36% |
| 3 | 19.92% | 32.36% |
| 4 | 4.98% | 15.88% |
| 5 | 0.13% | 1.55% |

Figure 2 shows the percentages of the service area population with respect to the fastest download and upload speed range available to them.[21] According to the NBM, forty-two broadband providers offer service somewhere in the service area. Maximum download speeds range from 3 Mbps to 1 Gbps, while maximum upload speeds range from 768 kbps to 25 Mbps.

**Figure 2. Maximum Speed Ranges Available for the Service Area Population**



Broadband subscribership rates are also lower in the service area than across the state. Federal Communications Commission (FCC) data from June 2012 show that 58 percent of households in the service area subscribe to an Internet service that has at least 768 kbps download speeds and 200 kbps upload speeds.[22] Nearly 63 percent of the state's households subscribe to an Internet service with the same minimum thresholds.[23]

Figure 3 presents the purchased bandwidth speeds of CAIs connected by Merit.[24] Each CAI may also accelerate speeds up to 1 Gbps over short periods at no additional cost. Two libraries and one community college, included in the figure at the 1 Gbps level, subscribe to Merit's Diverse Connection services, using the network as a redundant connection rather than purchasing a certain level of bandwidth. With the exception of these three CAIs, Higher Education institutions and K-12 schools tend to subscribe to the highest bandwidth available.

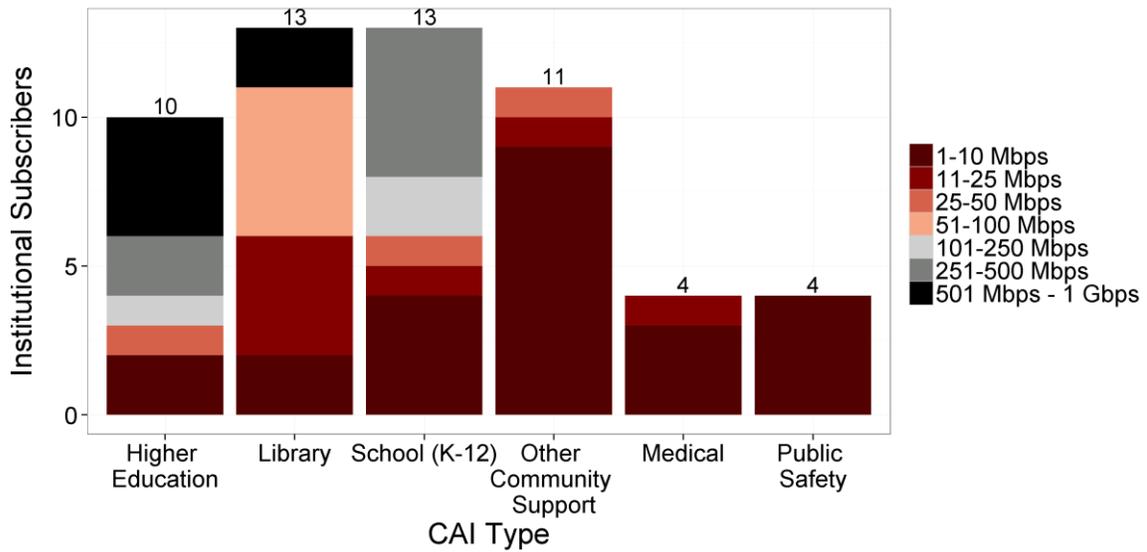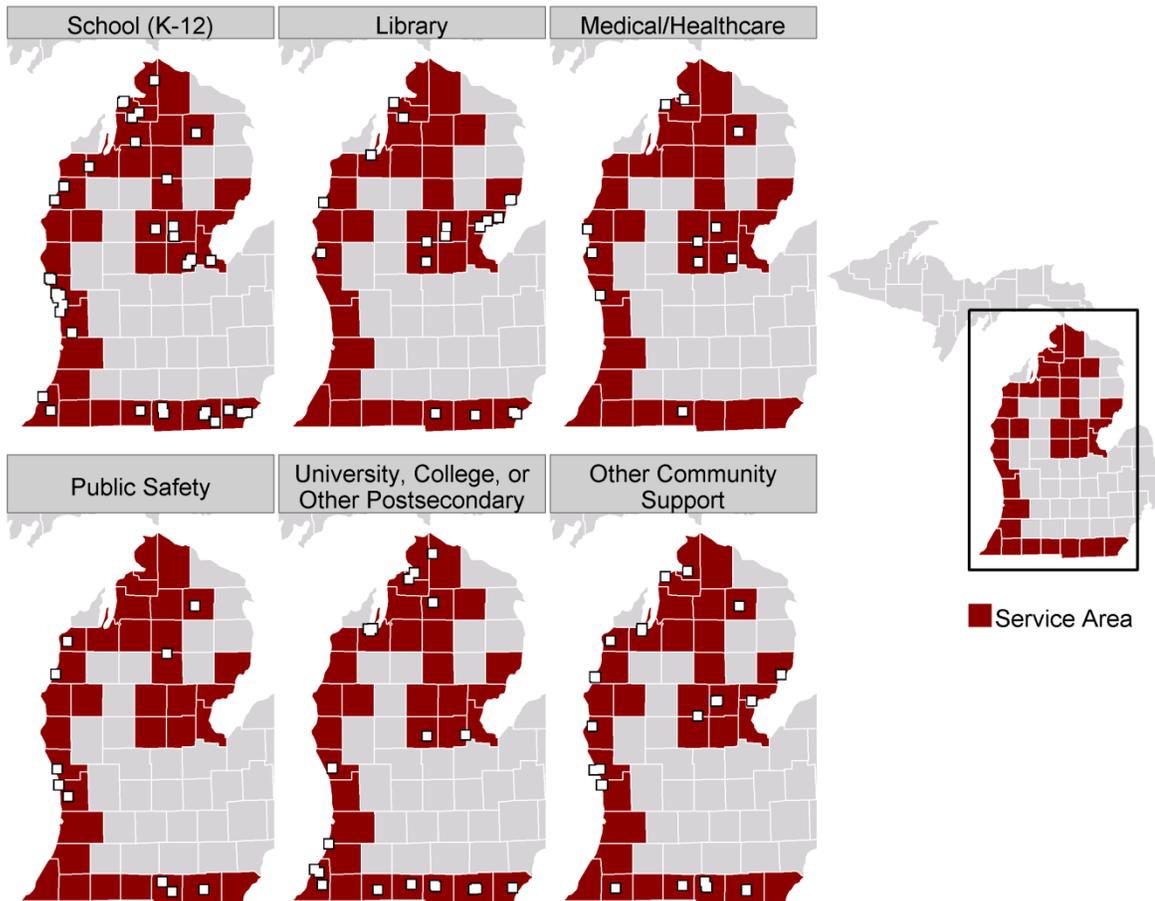## Figure 3. Subscription Speeds at Community Anchor Institutions



Figure 4 presents the grant's service area and the locations of CAIs connected by Merit.[25]

## Figure 4. Locations of Connected Community Anchor Institutions

The evaluation study team met with Merit staff, and middle and last mile providers throughout the Lower Peninsula of Michigan. These interviews helped the team understand the grantee's approach to project implementation and the strategies used to create demand for the broadband service. Additional interviews with key CAIs throughout Michigan's Lower Peninsula focused on describing the impact on CAIs in relation to several factors, including the quality of service of the upgraded network, especially speed, reliability, flexibility, and cost. The analysis in this report focuses on outcomes and impacts to CAIs. Interviewees include the following:

- Higher Education
  - **Lake Michigan College** (LMC) is a community college with a main campus in Benton Harbor and three other campuses in southwest Michigan. The college serves about 5,000 students. Most students are commuters, although the college was in the process of building a dormitory at the time of the site visit to house on-campus students. The college is also the largest provider of direct credit classes for high school students in the state, serving about 1,000 high school students per year.[26] LMC subscribes to three broadband providers for redundancy and backup. At the time of the site visit, the Merit grant had connected two of LMC's four campuses in a wide area network (WAN), and was planning to connect a third. The college increased its total bandwidth purchases at a cost savings of approximately $50,000 per year because of the REACH-3MC network. LMC also reported more efficient internal communications and data sharing because of the new network.[27]
  - **Adrian College** is a four-year liberal arts college in Adrian, Michigan with a student body of about 1,700. Adrian College is situated on the backbone of the Round 1 Merit network extension, and can receive service up to 10 Gbps. Adrian College increased its broadband subscription from 90 Mbps to 350 Mbps, while paying approximately the same price for service. At the same time, Adrian College reports that complaints regarding the quality of broadband service decreased to zero because of the improved connection to the Merit network. Students are now able to use the Internet in residential buildings to stay connected to family and friends, and instructors are not limited in the technologies they can use in the classroom.[28]
  - **The University of Michigan Biological Station** (UMBS) is funded and operated by the University of Michigan system. Founded in 1909 on heavily logged land in northern Michigan, UMBS is one of the oldest field stations in the United States. The station enables the study of ecosystems and biological organisms in their natural environments.[29] Before BTOP, the station subscribed to 3 Mbps of service through bonded T1 lines, which did not provide adequate bandwidth for faculty, students, or researchers. UMBS now uses speeds up to 1 Gbps for research applications including data transport from several field devices, internal communications using video conferencing, and an improved experience for undergraduates performing coursework at the station. UMBS pays about one-third of the price for the new fiber-optic connection than it did for the previous T1 service.[30]
  - **Hillsdale College** is a private liberal arts college with about 1,400 students, and is Hillsdale's largest employer. The college had existing fiber infrastructure before BTOP, but the REACH-3MC project provided it with reliable redundancy.[31]
- K-12
  - **Charlevoix-Emmet Intermediate School District** (ISD) serves K-12 school districts in Charlevoix and Emmet counties and two districts in Antrim County. The ISD serves 11 districts with about 9,600 students. Michigan's ISDs provide and coordinate essential services to their constituent school districts to facilitate teaching and learning beyond what the districts could provide on their own.[32] Many ISDs in the state served as colocation points for the REACH-3MC network. The Charlevoix-Emmet ISD collaborates with surrounding ISDs and districts to aggregate demand and facilitate resource sharing. While Merit directly connected some school and district buildings, others still connect to the Internet through cable and T1 lines. The ISD reported that it hopes to expand from the Merit fiber to create a single WAN among all of the districts it supports. The REACH-3MC network enables existing and future collaborations.[33]

- o **Charlevoix Public Schools** (CPS) is a small, rural school district that serves about 1,000 students. Enrollment has declined over the last 10 years from a peak of 1,500 students. The district includes an elementary, middle, and high school. In addition, they have an alternative education program on Beaver Island, however, this site is not connected to the Merit network. Although pricing data are not available, CPS more than tripled its subscription speed since the creation of the BTOP-funded network, from 30 Mbps to 100 Mbps. At the time of the site visit, the district was in the process of implementing a one-iPad-per-student initiative that would not have been possible without BTOP.[34]
- Library
  - o **The Houghton Lake Public Library** was established in 1969 as a school district public library, and transitioned to a district library in 1996 when Houghton Lake passed a permanent property tax supporting the library. The library has been a Merit member since 1998. The library provides computers and broadband access, including Wi-Fi, to the public. In addition to improved broadband access through Merit's BTOP grant, it received upgraded computers through Michigan State University's PCC BTOP grant. The library increased its subscription speed from 3 Mbps to 50 Mbps while reducing its cost from $1,333 to $500 per month. The library expects to increase its Qualified Service Checklist (QSC) ranking. The Library of Michigan uses the QSC to rate public libraries in the state, from "essential" to "enhanced" based on the improvements to services the Merit project has allowed.[35]
- Other Community Support
  - o **South Central Michigan Works!** (SCMW) promotes employment by helping job seekers find jobs and by working with businesses to ensure an adequately skilled workforce. It is one of twenty-five regional Michigan Works agencies and the only one to receive service through Merit's Round 1 BTOP grant. SCMW operates resource rooms in three counties that clients use to prepare résumés, search for jobs, and fill out online applications. SCMW also offers classes on digital literacy and job search activities. SCMW also has a Business Services component, working with businesses to recruit and provide ongoing workforce development training for employees. SCMW increased its broadband subscription from 6 to 30 Mbps as a result of REACH-3MC, at the same time its yearly costs decreased from about $10,000 to about $3,000. The increase in speed helped to provide more reliable internal communication and faster Internet service to clients both inside and outside of the classroom.[36]
- Healthcare
  - o **North Country Community Mental Health** (NCCMH) serves the mental health needs of the residents of six counties in the northern part of the Lower Peninsula including Antrim, Charlevoix, Cheboygan, Emmet, Kalkaska, and Otsego. It provides a range of publicly funded mental health services including psychiatry, counseling, therapy, nursing, case management, employment support, housing support, residential services for persons with developmental disabilities, and state hospitalization. In 2012, it provided services to 2,542 adults with serious mental illness, 845 children with serious mental disorders, and 775 persons with developmental and intellectual disabilities.[37] NCCMH's broadband costs have been reduced from nearly $70,000 annually in 2012 to approximately $63,000 in 2013, which includes some one-time charges for equipment purchases. At the same time, bandwidth at all connected NCCMH sites has increased from 3 Mbps through a pair of bonded T1s to 100 Mbps. This is an over thirty-fold increase in bandwidth and a 10 percent reduction in cost.[38]
- Public Safety
  - o The **Manistee County 9-1-1 Dispatch Center** supports tribal police, city police, sheriff's department, state police, twelve fire departments, and two ambulance services that serve Manistee County. The dispatch center also has mutual aid agreements with the surrounding counties of Mason, Wexford, Lake, and Grand Traverse. The center responds to about 30,000 calls per year that result in dispatches and employs 10 full-time dispatchers. The dispatch center's greatest benefit resulting from the BTOP grant is the ability to operate a virtual private network (VPN) between the center and the main county offices over the 1 Gbps Merit network. This allows for regular data backups and more reliable internal communication.[39]

- Middle mile provider and project participant
  - **Lynx Network Group** (Lynx), founded in 2003, is a middle mile provider and wholesaler serving rural markets in Michigan. Lynx participated in the REACH-3MC BTOP grant. The private company provides services to communications companies and businesses. Lynx owns 1,500 miles of fiber and 40 interconnection points, 22 of which are on the REACH-3MC Round 1 network. The company reported that owning fiber along most of the Round 1 REACH-3MC project has been transformational for their business, allowing it to expand its service area, to transition from resale of fiber owned by others to leasing fiber it owns, and to add nine staff members.[40]
- Last mile providers
  - **MiSpot** is a wholly owned subsidiary of Agri-Valley, an ISP in the Michigan counties of Huron, Tuscola, and Sanilac. MiSpot uses the middle mile REACH-3MC network to provide fixed wireless service to rural areas in the northern half of the Lower Peninsula. It would not have been able to serve many of these areas without the expansion of the middle mile network. Because of the increased middle mile access from the BTOP grant, MiSpot has been able to serve more customers, and has expanded from four employees to eighteen.[41]
  - **Sunrise Communications** is a multi-system cable operator that provides video, Internet, and voice services. Based in Onaway, Michigan, it serves the northern tip of the Lower Peninsula and the eastern portions of the Upper Peninsula. The current network primarily uses copper T1 lines, but at the time of the interview, Sunrise was transitioning to using the REACH-3MC fiber network to provide service to its customers. Sunrise reported that because of the grant, they will be more efficient in providing faster and more dependable service to rural northern Michigan. Specifically, Sunrise reported that it would be able to increase minimum speeds offered to customers from 512 kbps to 3 Mbps for the same price.[42]
  - **Allband Multimedia** is a nonprofit cooperative incumbent local exchange carrier (ILEC) enabling 9-1-1 services and providing Internet service to areas that would otherwise be unserved. It currently has between 500 and 600 subscribers in the northeast portion of the Lower Peninsula. The general manager reported that the ILEC is able to purchase wholesale services at a reduced rate because of the BTOP grant, and it is passing along this savings to customers.[43]

The evaluation study team also met with the following groups that provided information on the social and economic impacts of the grant, although they did not directly receive broadband service because of it.

  - **The Hillsdale Board of Public Utilities** (BPU) provides electric, water, and wastewater services to the city and surrounding areas. The BPU also serves a public safety function by providing these services to police and other city agencies. The BPU has a large stake in the city's ability to attract more businesses, as it has lost about 30 percent of the demand for utilities over the last several years from the loss of industry in the area.[44]
  - **The City of Hillsdale**, located in south central Michigan, was founded in 1839 and incorporated in 1865. The population has remained steady since at least the 1920s at about 8,300 residents, but it has lost a significant number of manufacturing jobs in the past decade. The City of Hillsdale contributed its own funds to get forty-eight strands of fiber included in the Merit BTOP build. Twenty-four strands are used under a memorandum of understanding (MOU) with the public sector. An additional twenty-four strands provide access to a manufacturing and technology park and to for-profit entities. The expectation is that one of the private-sector participants in the grant will provide businesses access to the BTOP network.[45]

Section 2 provides a summary of the outcomes and impacts the evaluation study team observed.

# Section 2. Impacts

This section describes the impacts of the Merit project in terms of the five focus areas described in *Interim Report 1*, with the addition of the Government Services focus area.[46] Digital Literacy is not a focus of CCI grants and the evaluation study team did not note significant Digital Literacy impacts outside of the outcomes and impacts related to the other focus areas.

The grantee confirmed that most of the CAIs participating in the grant were already broadband users, but at much lower bandwidths than the REACH-3MC fiber network could provide. Many had T1 connections, and increasing connection speeds was cost prohibitive. Others had fiber last mile but were limited by a lack of middle mile infrastructure. Of the fifty-five CAIs that were receiving service as of the site visit, twenty-one were previously receiving Internet through another provider, seventeen were Merit members but were on leased T1 circuits, and seventeen were part of a consortium of Merit members but did not have a direct connection to the Merit network before the BTOP grant.[47] The Merit project provided additional supply to meet the demand for bandwidth with these existing users, rather than increasing broadband adoption at CAIs that had no broadband connection.

## 2.1 Education and Training

Impacts within the Education and Training focus area are measured as changes to elements of educational content distribution and instruction. These impacts occur at K-12 institutions, community colleges, four-year institutions, universities, and other education providers. This focus area includes how the broadband Internet connections help the educational CAIs to perform activities that lead to helping students earn a certificate or diploma or receive training that is recognized as valuable for career advancement. Examples of certificates or diplomas include community college degrees, four-year college degrees, advanced degrees, general equivalency degrees, certifications in advanced software technologies such as network engineering, and other licenses or certifications that reflect knowledge of a particular subject at a level that would typically be taught at an educational institution.

When assessing impacts it is important to understand the characteristics and composition of education providers within the service area. Table 3 identifies the school level of all public schools in the service area.[48] The number of schools served by the grant in Table 3 likely under represents the actual number of schools benefiting from the network, as Merit counted many ISDs and school districts as single CAIs, even when these institutions passed along service to several schools.[49] Merit reported connecting more high schools and other schools than primary or middle schools. Merit also reported connecting one private secondary school.[50]

**Table 3. Michigan Public Schools (K-12) by School Level**

| School Level | Served by Grant | Others in Service Area |
|---|---|---|
| Primary | 8 | 399 |
| Middle | 3 | 151 |
| High | 10 | 237 |
| Other | 10 | 91 |
| Undefined | 16 | 0 |
| **All** | **47** | **878** |

According to Merit's reported data and publicly available data sets, Merit connected public schools that serve nearly 7,000 of the over 310,000 public school students in the service area.[51] Nearly 600 of these students are members of minority groups and nearly 3,000 qualify for free or reduced lunch. Connected schools employ nearly 460 full-time equivalent teachers. [52] However, during the site visit, Merit mentioned that many of the schools reported as connected are ISDs and school district offices that extended connections to more than one district or school. The actual number of students served may be higher than captured in the data, and demographics might be different from those presented above.

Merit also connected twenty-nine of the fifty postsecondary institutions in its service area.[53] Sixteen of the connected institutions grant four-year degrees or above, while thirteen are public institutions that grant two-year degrees.

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Distance learning opportunities allow schools to broaden the variety of courses offered. They also represent an educational resource for nontraditional or disabled students, or those living in geographically remote or poor areas.[54]**
  - o CPS increased its broadband subscription from 30 Mbps before REACH-3MC to 100 Mbps after, and pays approximately the same price. The district is leveraging these speeds to offer new classes in computer programming for high school and a robotics class for middle school students in an effort to prepare students for careers in technology. These classes are either entirely web-based or highly dependent upon web content, including streaming videos and interactive online applications. These classes would not be possible without the connection to the REACH-3MC network the school received because of the BTOP grant.
  - o LMC offered thirty-four online classes and thirteen hybrid classes in the fall 2013 semester.[55] Both these and in-person classes use Canvas as a learning management system (LMS). In addition, as part of the Michigan Community College Association, LMC is planning to introduce a new service model for online classes from a learning repository in California. LMC reported that this kind of service requires the high speeds and low latency that the Merit network provides, and that it would not be able to offer as many distance learning opportunities without the new connection.
  - o LMC is using the Merit network to develop relationships with other educational institutions. For example, it leveraged a grant to install seventeen Skype units in K-12 schools for remote classroom observation, counseling, and advising. The schools on the Merit network are taking advantage of the 1 Gbps on-net connection with these video capabilities.

- **Innovative use of web resources, such as using social networking sites as learning management tools, leads to greater student-teacher engagement.[56]**
  - CPS is using its increased speed to implement a one-to-one iPad initiative, which would not have been possible before BTOP. Teachers and students use the iPads to access Edmodo, a web-based social learning platform that allows them to interact both in and outside of the classroom. Many teachers are using the application to transition to a flipped classroom, where teachers record lectures and screencasts for students to watch as homework and spend classroom time doing interactive activities.
- **Broadband gives teachers a wide range of media through which to facilitate lessons. The integration of technology into classroom activities creates the opportunity for interactive and personalized educational experiences for students.[57]**
  - CPS uses its broadband connection to instruct with SMART Boards. One application of this technology is watching and annotating online videos to enhance the learning experience of students. The technology director for the district noted that teachers used these technologies before BTOP, but the new connection makes them faster and more reliable.
  - Since implementing the one-to-one iPad initiative, Charlevoix High School staff members have observed students helping teachers and one another with laptops and iPads. The school plans to implement a help desk staffed by students to formally assist students and teachers with technology. The opportunity for students to gain experience in technology instruction would not be possible without the increased use of technology that the BTOP-funded network facilitated.
  - Charlevoix High School started an alternative education program for fifteen to twenty students that use the Internet heavily for instruction. Teachers in the program use web resources to offer more interactive lessons for students who disengage quickly in lecture-based learning environments. The technology director reported that without BTOP, the school would not be able to offer this type of instruction.
- **Research has shown that computer use among students leads to improved academic performance, greater levels of educational attainment, improved school enrollment and graduation rates, and increased earning potential for students.[58]**
  - Some teachers at CPS are using new online applications to individualize instruction and reach more students. For example, the district has begun to use the social learning platform Edmodo to facilitate student and teacher engagement. One teacher encourages her students to communicate with her in the evenings via Edmodo. This prevents students waiting until the next day in class when there might not be enough time to address every student's questions or concerns. This teacher has found a significant decrease in the number of students failing her class after implementing these changes to her instruction.
- **School administrations leverage broadband infrastructure to carry out internal operations. Broadband represents a rapid, reliable channel of communication to improve interactions among administrators, teachers, parents, and students.[59]**
  - Lake Michigan College (LMC) developed a high-speed WAN between three out of four of its campuses. The college reported that this increase in speed would have been too expensive without the REACH-3MC network. It is also planning to build a dorm building to house students on campus, and will likely increase its bandwidth further to accommodate the residential building.
  - LMC experiences cost savings with cloud-based services such as virtual PCs, which are less expensive to replace on a regular basis than desktop computers. Cloud-based software applications are also becoming more common, which often presents an opportunity for cost savings as well. These applications require a fast and reliable broadband connection, and the fiber that Merit installed will assist with these future needs.
  - LMC has noticed a difference in performance since the upgrade to Merit fiber, particularly using voice over Internet protocol (VoIP) telephones, which also have a four-inch video display. The college is now also able to transfer security videos faster and more reliably over the Merit WAN. The increased efficiency of the network has influenced their planning

strategy. Before REACH-3MC, LMC had to rely on a distributed server model because they did not have a fully redundant network between buildings. Now, the college can shift to a central office model with servers hosted in one location. This makes managing the network easier.

- o Before BTOP, Merit leased DS3 circuits from Frontier to provide service to Adrian College. The network upgrade supports the systems Adrian College hosts on campus, including Blackboard Collaborate for student-teacher interaction and assignment submission and BlackBaud as a student information system. The improved bandwidth has also influenced future data storage and retrieval plans. The college is looking into hosting more data on its own servers and purchasing cloud services from Merit. It has begun conversations with other Merit members and it is hoping to realize further cost savings by consolidating services using the 1 Gbps network.

- o LMC IT staff members have presented a model for shared services to their board. These could include consulting, managed hosting, and co-hosting services. For example, the college is interested in pursuing a partnership with another college to share data centers. This could allow LMC to receive better service for the same price. These conversations are possible because of the 1 Gbps statewide Merit network connecting institutions of higher learning.

- o Michigan Public Schools will be required to implement online testing in the 2014-2015 school year, and this will increase demand on Charlevoix Public School's broadband network. CPS IT staff noted that it would be difficult for all students to access the tests simultaneously without the increased bandwidth.

- **School districts may realize cost savings by conducting staff training activities online rather than using hardcopy training materials or hosting in-person training sessions.[60]**
  - o CPS uses a train-the-trainer approach to training teachers in digital literacy and education-specific applications of technology. A small number of teachers travel to participate in training, and train other teachers at schools within the district. The school also offers some online training, including an iTunes U course with resources on applications teachers can use in the classroom. The district has prioritized alternative and interactive learning environments. Technologies made possible by increased broadband speeds are giving them a greater ability to access these trainings and implement this style of instruction.

  - o The Charlevoix-Emmet ISD has video conferencing equipment set up between some schools for staff meetings both within and between school districts. This saves both money and staff time. For example, the school principal on Beaver Island occasionally joins meetings remotely instead of flying to Charlevoix. After implementation of the REACH-3MC project, more schools can connect to the Merit network and use the free on-net 1 Gbps service for video conferencing.

In addition to the impacts mentioned above, the Merit network also facilitated data collection for research at postsecondary institutions.

- Before BTOP, UMBS used two bonded T1 circuits along with a wireless network shared with the local ISD. They were above capacity every day, and data exchange from field measurement devices was slow. Now they subscribe to 1 Gbps service. UMBS staff reported that the increased broadband revolutionized their ability to transfer real-time data to researchers.

- UMBS is now able to apply for National Science Foundation (NSF) funding for long-term projects that require a high level of data management standards.

- Many UMBS faculty work with graduate students located across the world and need to communicate with them. The improved broadband speeds provide faculty with reliable video conferencing, which was nearly impossible with the bonded T1 line connection. This allows the station to better attract leading researchers from around the world.

## 2.2 Workforce and Economic Development

Impacts within the Workforce and Economic Development focus area can occur through activities intended to increase overall employment of the target population, or to assist employed members of that population in finding jobs that offer increased salaries, better benefits, or a more attractive career path, including self-employment. This focus area also includes activities to attract new businesses to locate along the fiber path or to expand the economic activity of existing businesses connected to the network. While this focus area primarily describes jobs, it also includes other economic impacts such as wages, property values, and the number of firms in a region.

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Access to computers and broadband helps to reduce unemployment by enabling job seekers to engage in training programs, facilitating job seekers' ability to search and apply for open positions online, and reducing geographic limitations associated with employment search.[61]**
  - SCMW provides training, support services, and broadband access to job seekers. The organization offers classes including Microsoft Office, job search, Internet navigation, introduction to computers and digital literacy. Broadband is important to classroom instruction, as many of the classes require each student to follow along in a web browser. SCMW increased its broadband subscription to 30 Mbps aggregated between three sites and reported that both speed and reliability are noticeably better. Improved broadband service has not changed the courses offered to clients, but it does allow SCMW to deliver classes more efficiently. Before BTOP, the Lenawee County resource center would reach capacity at least weekly, slowing the pace of classes, and limiting the time devoted to hands-on learning. Occasionally, classes had to be rescheduled or cancelled due to network outages. This has not happened since the upgrade. One SCMW trainer reported being able to increase class size from ten to twenty students because of the improved broadband connection.
  - About half of the companies SCMW works with require online rather than paper applications and this number is growing. Although broadband is available where many job seekers live, many cannot afford the monthly cost. As a result, SCMW serves as an important access point for its clientele to perform job search activities. According to staff, the slow broadband connection speed before BTOP sometimes frustrated job seekers. Now, they can search for jobs and complete applications more easily.
  - The REACH-3MC network has increased operational efficiencies at SCMW. Before BTOP, the three offices did not subscribe to service through the same provider. Through REACH-3MC, SCMW was able to consolidate services, and Merit now runs SCMW's WAN to all three sites. SCMW does not pay for any traffic between its sites, and access to the 1 Gbps on-net speed has improved operations. For example, the offices use the new, reliable VoIP and video conferencing system to communicate instead of traveling between offices.
  - SCMW has the capability to allow clients to perform interviews remotely through Skype, allowing them to apply for jobs in other locations. The increased broadband speed makes these video interviews more reliable.

- **Workforce and Economic Development activities supported by broadband infrastructure strengthen job and population growth.[62]**
  - MiSpot provides fixed wireless services to several areas in the northern half of the Lower Peninsula. The increased access to middle mile fiber in its service area has allowed MiSpot to expand its business, and it has grown from four to eighteen employees. MiSpot's parent

company has also added several employees to provide technical support for MiSpot's networking equipment.

- o Lynx Network Group purchased strands on nearly all of the REACH-3MC fiber lines. This allowed it to shift its business from resale to leasing fiber it owns, and the company reported that this was transformational for its business. Because of the amount of work involved in the build out, Lynx added nine staff members.
- o According to middle and last mile providers that expanded their businesses because of the increased capacity, the infrastructure build out has also benefitted the construction companies responsible for last mile contracts.

- **Access to computers with broadband connectivity enables additional employment options and increased earning potential for workers, such as entrepreneurial activities, independent investment and contracting opportunities, and work-from-home positions.[63] Broadband connectivity enables increased telework opportunities.[64] Broadband access to facilitate such capabilities is especially significant to economic growth in geographically remote areas.[65]**
    - o The REACH-3MC network expansion to Hillsdale will facilitate last mile providers, including the project participant TC3, to offer fiber-to-the-premise (FTTP) to its residential and small business customers. This presents the opportunity for residents to telecommute from home, which might help keep graduates from Hillsdale College in Hillsdale. Many of these graduates would otherwise seek employment elsewhere.[66]
    - o The increased availability of broadband might create the possibility of telecommuting in rural areas and increase opportunities for rural businesses to compete on a larger scale. All of the ISPs the evaluation study team interviewed described customers who were using the connection to telecommute or run small Internet-based businesses.

- **New or enhanced connectivity benefits businesses by enabling the use of applications and processes that increase productivity and efficiency.[67]**
    - o SCMW works with employers to provide computer training in software applications for employees, serving more than 800 employers comprising two-thirds of the employers in Lenawee, Hillsdale, and Jackson counties. Employers encourage employees to take SCMW's free computer classes to acquire digital skills, and thereby increase workplace productivity. The increased broadband speed allows SCMW to offer these classes more efficiently to more students.

- **Broadband access allows businesses to enhance marketing strategies by growing or establishing web presence, increasing the frequency of customer interaction, and thereby increasing customer bases.[68]**
    - o When Merit installed the REACH-3MC fiber in Houghton Lake, the county appointed a broadband committee. This committee's activities include assisting small businesses with the use of broadband for business activities. Getting small businesses online is particularly important for the town during tourist season, when tourists driving on nearby I-75 look for restaurants and hotels on their smart phones. The county might not have provided these outreach services without the REACH-3MC project.
    - o The Houghton Lake Public Library engages the community in promoting economic development. For example, it produced a marketing brochure written by children called "For Kids by Kids," highlighting what kids like best about Houghton Lake. Now that better Internet access is available at the library and in the community, the library is planning to create an online version of the brochure to put on websites that tourists would visit before coming to town.

- **The availability of infrastructure in a community enables firms reliant on broadband services to relocate or open additional locations. Local businesses are able to obtain improved access to inputs and markets.[69]**
    - o The REACH-3MC network provided triple path redundancy in the Hillsdale area, and the city's economic development consultant is using this to attract data centers to the area. The
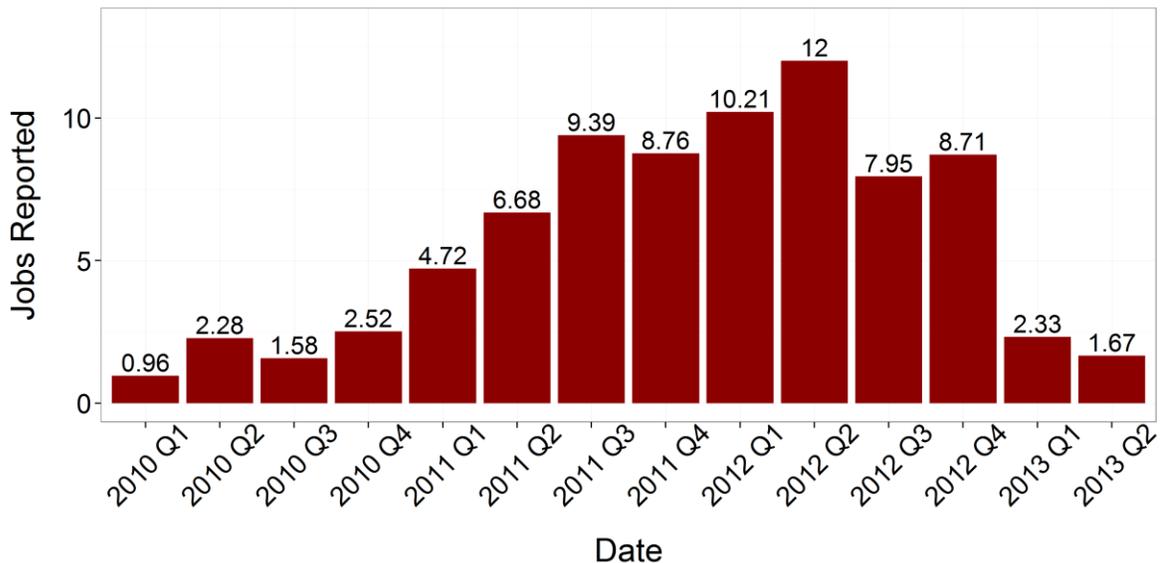
city passed a technology overlay district (TOD) in order to open the possibility for data centers and technology-heavy businesses to build in a manufacturing and technology park.

- o Hillsdale lost manufacturing jobs as large industrial employers moved out of southern Michigan. In addition to increasing unemployment, this trend has also decreased demand for electrical power provided by the BPU. The BPU is currently operating with about 30 percent less demand than capacity, but it needs to maintain the same infrastructure. BPU officials are hopeful that improved broadband availability will attract new businesses to the area, increasing the demand for the excess capacity.
- o Merit reported that it received requests for splice points from at least two of the participant companies that developed contracts to connect business parks to fiber. Lynx has met with several industrial parks and is planning to build fiber to them in the future. This connectivity increases bandwidth to existing companies and allows the parks to market to new, high-tech companies.

At the time of the site visit, Merit reported that it was finding it challenging to keep up with the number of requests for new or improved service. Merit hired nine people to assist with the processing of these requests. Merit also hired four regional managers to provide services to existing and potential members, and the equivalent of one and a half full-time employees to address connecting CAIs to the network. Finally, it added a business manager to help coordinate for-profit inquiries, an accountant to handle billing and invoicing, and an administrative assistant. The BTOP grant did not directly fund all of these positions.

As required by the Recovery Act, Merit reported the number of jobs created quarterly as a direct result of the project. Figure 5 shows the number of direct jobs created by Merit over the grant period.[70] Merit funded an average of nine and a half jobs from the third quarter of 2011 through the fourth quarter of 2012. The largest number of jobs funded in one quarter is twelve, in the second quarter of 2012. It is important to note that this includes only direct jobs created, and does not include indirect or induced job creation.[71]

**Figure 5. Direct Jobs Created by Merit**

This focus area includes activities intended to increase elements of the provision and administration of healthcare services, including health information technology, e-Care, electronic

health records (EHR), telehealth, and mobile health. Impacts in the Healthcare focus area include broadband-enabled activities aimed at improving personal health or that of someone else. This definition includes not only sophisticated tasks, such as viewing medical records online, but also more common activities that might not involve a medical provider at all. Healthcare impacts might be observed at primary care physicians' offices, hospitals, or in areas served by nurse practitioners.

When assessing impacts it is important to understand the characteristics and composition of healthcare service providers within the service area. Merit had connected twelve healthcare institutions by June 30, 2013.[72] Table 4 identifies the taxonomy groups of these connected institutions and the taxonomy groups of all healthcare institutions in the service area according to the National Plan and Provider Enumeration System (NPPES).[73] The twelve institutions are split evenly between two groups: community mental health clinics and hospitals.[74]

### Table 4. Michigan Healthcare Institutions by Taxonomy Group

| Taxonomy Group | Served by Grantee | All in Service Area |
|---|---|---|
| Agency | 0 | 433 |
| Community Mental Health Clinics | 6 | 501 |
| Hospital Units | 0 | 17 |
| Hospitals | 6 | 68 |
| Managed Care Organizations | 0 | 22 |
| Nursing & Custodial Care Facilities | 0 | 146 |
| Residential Treatment Facilities | 0 | 59 |
| All | 12 | 1,246 |

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Access to online health information enhances patients' ability to seek care, select a provider, and choose treatment options, improving outcomes for physical and mental illness.[75]**
  - o The Houghton Lake Public Library offers health and medical databases for patrons through the Michigan E-library, and librarians instruct the public on how to find reliable health information in beginning computer classes. The library reported that many patrons do not have sufficient broadband speeds at home to access databases and depend on the library for this task. The faster broadband speed the library received through REACH-3MC lets patrons access these databases quickly and reliably.
- **Patients are able to obtain more accurate prescriptions in a shorter amount of time.[76] Improved access to patient information also reduces the likelihood of drug interactions resulting from multiple prescriptions from different providers.[77]**
  - o NCCMH is helping to pilot a project to integrate health services by sharing patient claim data between primary care services, pharmacies, and mental health services. NCCMH has found that broadband can facilitate this integration by allowing the fast exchange of electronic medical records (EMR). According to the NCCMH director, behavioral health and Medicaid consumers have contact with their behavioral healthcare provider four times more often than with their primary healthcare provider. The integration of patient information can help

NCCMH psychiatrists and staff to remind their patients to fill prescriptions for physical health problems. Similarly, many patients seek mental health care through their primary physicians who can use the integrated system to view medical records related to behavioral health. Before BTOP, NCCMH offices subscribed to service at or below 4 Mbps, and EMR transfer was often very slow. The improved broadband speeds received through the REACH-3MC project helped to improve transmission of medical records.

- **Broadband connectivity enables providers to adopt new technologies and practices that enhance productivity, achieving outcomes such as improved appointment and treatment scheduling and more complete medical records at lower costs.[78]**
  - o Two NCCMH locations were connected by the Round 1 grant, including the main office in Petoskey and a remote office in Charlevoix. Three additional remote offices were connected through Merit's Round 2 grant. The increased broadband speed allows NCCMH to process all payment transactions as one large file, which helps them meet deadlines for the completion of required paperwork.
  - o NCCMH serves a rural population in many areas that are unserved or underserved by broadband. The lack of broadband access in these areas affects case managers' ability to transfer documents and data about their clients to administrative offices when they are visiting clients. They use laptops and wireless devices to transfer this data where they can access a wireless signal, but they often have to spend time downloading documentation when they return to the office. The REACH-3MC middle mile fiber runs through every county in its service area, which opens the possibility for last mile providers to extend broadband service. Allband, MiSpot, and Sunrise have interconnected with the REACH-3MC network to provide broadband to rural areas.
  - o NCCMH subscribes to an online service through NetSmart Technologies called myLearningPointe that provides required online training on several topics for staff, including HIPAA, working with clients who have limited English proficiency, and workplace safety.[79] Conducting training online saves staff time and allows them to complete training within their schedules. While NCCMH used this service before BTOP, the increasing demand from EMRs on existing bandwidth would have slowed the pace of the trainings without improved bandwidth obtained through the REACH-3MC project.
  - o REACH-3MC improved the telephone service at NCCMH. The offices use VoIP for internal communications, and the on-net speed of 1 Gbps makes phone calls more reliable and clear.
  - o NCCMH was an early adopter of video conferencing, but increasing bandwidth demands from the telephone system, medical records, and the amount of data that had to be submitted to the state required limited use of video conferencing. Now that the agency has more bandwidth, it is considering new equipment for video conferencing in the future.

- **Broadband access enables providers to rapidly share patient information with other healthcare providers.[80]**
  - o According to NCCMH staff, without the improved broadband connection through Merit, NCCMH would not be able to share medical records with other health care providers in the state. The free on-net symmetrical bandwidth up to 1 Gbps makes this sharing fast and inexpensive.

- **Broadband enables providers to improve the range of health services offered.[81]**
  - o The rural nature of the NCCMH service area requires psychiatrists to drive long distances to serve clients, takes time away from their practice, and costs NCCMH expensive travel fees. In the future, NCCMH would like to implement more tele-psychiatry from NCCMH offices, and the faster connection they received through REACH-3MC makes this possible. However, much of the service area does not currently have access to broadband in residential areas, and where it is available, many Medicaid patients cannot afford it. Because of this, NCCMH is piloting the use of tele-psychiatry to communicate with other doctors' offices rather than clients' homes. The agency is participating in a University of Michigan program called MC3 to provide consulting psychiatry service to primary healthcare providers

that are managing pediatric patients with behavioral health problems. The MC3 program would allow psychiatrists to consult with primary care physicians and their patients so that they can better manage behavioral health issues.[82]

## 2.4 Government Services

One of the five core purposes established by the Recovery Act was to "improve access to, and use of, broadband service by public safety agencies."[83] The Government Services focus area identifies how broadband improves services provided by government organizations to the public and includes both the provision and administration of public safety activities. Examples of public safety agencies include law enforcement agencies, fire departments, and emergency medical services (EMS). Some potential government service impacts include enhanced government efficiency, improved ability to save lives and reduce injuries, prevention of criminal activity, and improved information sharing between citizens and public safety entities.

When assessing impacts it is important to understand the characteristics and composition of government service providers within the service area. Table 5 identifies the agency type of all police departments in the service area.[84] Merit connected four local police departments and one sheriff's office under the grant. It also connected 2 local fire departments, out of 292 in the service area. The remaining five public safety entities connected by Merit are emergency call dispatch centers.[85]

### Table 5. Michigan Police Stations by Agency Type

| Agency Type | Served by Grantee | Others in Service Area |
|---|---|---|
| Local police department | 4 | 122 |
| Sheriff's office | 1 | 32 |
| Primary state law enforcement agency | 0 | 0 |
| Special jurisdiction | 0 | 4 |
| **All** | **5** | **158** |

Police departments connected by Merit employ eighty-one full-time sworn officers, three part-time sworn officers, and thirty-nine civilians.[86] Connected fire departments employ nineteen career firefighters.[87]

This section summarizes the activities observed by the evaluation study team during site visits. This report lists impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **The use of broadband at all levels of government allows government entities to deliver services more efficiently. Intranet systems enable the secure and rapid exchange of information among government agencies. Governments are also able to store and safeguard massive quantities of data. By streamlining in-house operations with the use of broadband-supported tools, governments realize greater internal efficiency and productivity.[88]**
  - Before BTOP, Manistee County distributed a request for information (RFI) for new broadband service. The main reason for the upgrade was to install a secure VPN between the sheriff's office and the main county building to share information between data centers. One of the main factors in its decision to connect to the REACH-3MC network was the free 1 Gbps internal network, which the county would not have been able to afford from another provider. Now, county data is securely backed up between the two data centers on a regular

basis. At the time of the site visit, the county was also planning to connect the 9-1-1 dispatch center to the VPN.

- o The Manistee County jail is colocated with the 9-1-1 dispatch center and sheriff's office, and is also connected to the Merit network. The county jail uses the REACH-3MC broadband connection for video arraignment to reduce the cost and security risk of transporting defendants to a courthouse in a different county. The jail could not do this before BTOP.
- o The sheriff's department uses the broadband Internet connection for research and training for officers. The department's incident reporting system allows neighboring public safety agencies and those throughout the state to aggregate reporting data into one database. Each agency may search the database for information on prior incidents.

## 2.5 Quality of Life/Civic Engagement

The Quality of Life/Civic Engagement focus area includes activities that create stronger and more integrated communities through broadband. Impacts within this focus area are measures of broadband capacity for local institutions that provide public access and training in technology, such as libraries and other community centers.[89] These institutions provide support for individuals to participate in activities that benefit their communities and society, access information about government, participate in communities and civic associations, engage in education and training, seek employment, and establish or support small businesses. For some residents, this public access provides their only means of Internet connectivity. For others, it provides a place to seek assistance, to learn, and to share ideas and information with others. Support of public broadband access is therefore a means of enhancing the civic commons and the quality of life in the community. There is growing evidence that while libraries are beginning to offer more services to support quality of life and civic engagement, over 75 percent of public libraries are falling behind in having adequate broadband speeds to meet the needs of the public.[90]

When assessing impacts it is important to understand the characteristics and composition of civic organizations within the service area. Merit connected 18 of the 130 libraries in its service area.[91] Table 6 identifies the locales of all libraries in the service area.[92] The Institute of Museum and Library Services (IMLS) determines locales based on the proximity of libraries to urban centers and their location in Census-designated rural territories.[93] All eighteen connected libraries are located in towns or rural areas.

### Table 6. Michigan Libraries by Locale

| Locale | Served by Grantee | Others in Service Area |
|--------|-------------------|------------------------|
| City   | 0                 | 6                      |
| Suburb | 0                 | 8                      |
| Town   | 5                 | 28                     |
| Rural  | 13                | 70                     |
| **All** | **18**           | **112**                |

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Citizens save time and money by accessing content online rather than traveling to a government office or waiting to speak with a representative via telephone.[94]**

- o Clients at SCMW use the resource center computers to apply for unemployment, Department of Human Services benefits, My Child insurance, and to fill out the Free Application for Federal Student Aid (FAFSA). BTOP has made this process faster and more reliable.
- **Using broadband for general social interaction improves social connections, especially in rural communities that tend to be sparsely populated or in other cases where parties must communicate over significant geographic distances.[95]**
  - o The new fiber allowed students and researchers at UMBS to have the same access they would find on the main University of Michigan campus in Ann Arbor. This can allow them to maintain improved social interactions while at the remote location. The UMBS fiber was lit in the summer of 2012 when students were on the campus and faculty, staff, and students noticed the improvement in speed immediately. This improved UMBS's ability to interact with top researchers worldwide, and helps to maintain the status of UMBS as a premier biological research facility.
  - o Before BTOP, the IT department at Adrian College received consistent complaints from freshman about the low Internet speeds available to them throughout campus. The IT director reported that as soon as the new connection to Merit was established, the complaints stopped completely. Improved broadband service because of the REACH-3MC project allows students to maintain social relationships through social networking sites and tools such as Skype.
- **Broadband lowers the effective cost of civic engagement by offering citizens flexibility in when, where, and how they can participate.[96]**
  - o The bandwidth allows the Houghton Lake Public Library to enhance the programs and services it offers. For example, it plans to do another For Kids by Kids project, incorporating videos of students talking about their favorite aspect of the Houghton Lake community. This will allow more students to be involved, and engage those who would rather not write or draw. It also facilitates their promotion of community service to students, as the library uses the connection to communicate with them about service opportunities via Facebook.

# Section 3. Grant Implementation

This section presents Merit's strategy to maximize the social and economic impacts of the BTOP grant. The following subsections describe Merit's implementation strategies; Merit's approach to open access; major results of Merit's implementation strategy; an overview of sustainability efforts; and successful tools, techniques, and strategies identified during interviews with the grantee.

## 3.1 Implementation

Merit Network, Inc. is a 501 (c)(3) nonprofit broadband service provider headquartered in Ann Arbor, Michigan. Merit has built and operated networks for anchor institutions throughout the State of Michigan for forty-seven years, supporting the education and not-for-profit community. Founded in 1966 by Michigan State University, the University of Michigan, and Wayne State University, Merit Network has primarily focused on meeting the last mile broadband access and service needs of their founding member institutions to support education and research missions.[97] Their membership has since expanded to include last mile service to public and private higher education institutions throughout Michigan and an increasing number of other organizations, such as government agencies, public safety agencies, health care organizations, libraries, K-12 schools, and other community organizations.[98]

Merit is governed by twelve, four-year public universities located in the State of Michigan. Each governing institution appoints one representative who acts as a liaison to Merit on behalf of that institution. Collectively these representatives serve as the Board of Directors of Merit Network, Inc.[99] The Merit Advisory Council (MAC), formed in 1998, provides a platform for non-governing Merit members to communicate with each other and with Merit. Merit's non-governing members elect new representatives to serve on the MAC for three-year terms. The MAC meets a minimum of twice each year to discuss Merit's service and to provide direct feedback to Merit's staff and board of directors.[100]

Merit has extensive network construction and operation experience. Merit was one of three partners that built the NSFNET, the forerunner of the commercial Internet. Merit is fully staffed with senior engineers, network operators, and management personnel. Prior to the additional 1,000 network miles built under the BTOP Round 1 grant, Merit managed the 1,600 fiber miles in its network, delivering services over its passive optical networking (PON) platform.

In 2003, Merit made the strategic decision to move away from a leased asset business model to an asset ownership model. As funding allowed, Merit would incrementally increase the fiber infrastructure it owned throughout the state. Initially, the majority of the activities surrounding this strategy resulted only in acquisitions in the more populated southern areas of the Lower Peninsula, which afforded the greatest opportunity to serve as many customers as possible. Immediately preceding the BTOP Round 1 award, Merit acquired fiber in the Upper Peninsula to serve three of its governing member institutions. This new strategic ownership model was reflected in the BTOP grant implementation, which allowed Merit to expand its service area to nearly all areas of Michigan except for the "thumb" region in east central Michigan. This model has also allowed Merit to maximize its responsiveness to meet the needs of current members, to proactively identify and engage prospective last mile members and providers, and to better control costs.

In addition to operating from its headquarters in Ann Arbor, as part of its service area extension Merit developed a local presence throughout the state in regional offices. Many member relationships are fostered through partnerships with local organizations or CAIs that have taken a lead role in championing broadband access in their community, especially in unserved and

underserved regions. The Roscommon County Broadband Committee is one example of a community organization assuming this leadership role.

With the exception of about 35 miles of existing network fiber that was upgraded, the REACH-3MC middle mile project adds 1,010 miles of new infrastructure to Merit's existing 1,600-mile network. Merit explored the option of purchasing Indefeasible Rights of Use (IRU) to interconnect existing fiber where possible in the grant-funded service area, but there was little fiber available to do so. As a result, Merit pursued new construction as the only feasible alternative for the majority of the network expansion.

Because of time constraints, Merit completed the network design necessary for the Environmental Assessment before engineering was complete. Merit had to submit more than 200 small route changes to NTIA because of engineering requirements and input from cities along the fiber route. In some cases, utility pole owners did not provide permits for the poles on the original route. In other cases, cities prohibited Merit from building below ground for fear of disturbing utility or sewage lines. In tourist areas, underground construction was too expensive because of high replacement costs for sidewalks. The ratio of aerial to buried fiber increased after the route changes. At the time of the site visit, Merit estimated that approximately two-thirds of the fiber miles were aerial and about one third was underground. In addition to the time spent submitting route changes, Merit also incurred the cost of replacing more poles than originally anticipated for the aerial portion of the deployment.

Merit deployed a wavelength division multiplexing passive optical networking (WDM-PON) solution over the fiber-optic network backbone and laterals. This provides ample capacity for multiple providers to connect to and offer services over the network. This technology allows Merit and other providers to make network upgrades and service changes with a minimal investment of time and cost by swapping out end-point equipment, as opposed to laying new or additional fiber-optic cable. Even with service-level contracts in place, customers have room to upgrade their service. Third-party service providers have access to the backbone at strategically placed network interconnection points spaced at approximately 1,500- to 2,000-foot intervals along the route.

The REACH-3MC network expands Merit's existing network by facilitating the construction of a ringed backbone architecture that provides at least two points of connection at major network hubs, and built-in, on-net path diversity to and from the network core. The network also has two major exit points to the Internet: a route to Chicago and a route to Toledo. A third path serves a site in Sault Ste. Marie and interconnects with a network in Ontario, Canada. This provides redundancy between major network interconnection points. The laterals are direct, single route connections from the backbone to CAIs or provider facilities. In some instances, larger CAIs and providers either invested in a redundant connection, or were able to achieve such a connection after Merit chose them as sites to host a backbone node for the REACH-3MC network.

The Merit network connects its members by way of a 1 Gbps link and can be used as a large-scale enterprise network due to Merit's policy of free (zero cost) transmission of data on-network. The network hosts much of the content and cloud services the CAIs access, such as virtualization, hardware, and software services in local data centers. This configuration reduces provider and customer costs and increases performance and reliability. For example, 50 percent of Adrian College's traffic stays on-net, including Internet2 traffic, which is hosted on the network because of peering agreements Merit has established with other state research networks. Merit staff members observe that members choose to purchase more bandwidth with their increased cost savings.

Another benefit to members is that they can temporarily exceed their purchased bandwidth and use up to 1 Gbps without incurring overage charges or having to subscribe to a higher service level. To incur what is termed "burstable charges," a CAI must sustain bandwidth use above its subscribed bandwidth on consecutive days for a 30-minute period or more. Smaller "bursts" in usage, such as the one-time broadcast of a popular event, do not incur these charges.

Merit is continuing to develop additional value-added services for its members. It provides training and certification programs, such as cyber security courses through its Michigan Cyber Range program. Merit also hosts special member events such as a virtualization conference and an annual member conference. They have a product development department to develop new services to continue to add value to the network for its members.

## 3.2 Open Access Policies

CCI projects funded by BTOP are predominantly middle mile projects, although a small number of last mile projects were awarded. These grants are intended to improve available broadband capabilities for CAIs, to facilitate the development of last mile services in unserved and underserved areas, and to promote economic growth. This investment through the BTOP grant is intended to "lay the foundation for the ultimate provision of reasonably priced end-user broadband services" through open and nondiscriminatory interconnection strategies to enable last mile providers to have open access to the network.[101]

There is considerable debate on the impact of open access policies on the competiveness of the broadband market.[102] Open access is implemented through a wide variety of strategies. "These can range from commercial or voluntary arrangements, between communication operators and third-parties, through to regulatory intervention aimed at promoting certain policy objectives, such as expanding broadband availability, increasing competition, or promoting investment that may otherwise not be economic, such as in the case of enabling the establishment and treatment of shared facilities."[103] The impact of open access will be dependent upon how well the practices and policies help to reduce the time, cost, and difficulty for last mile providers to interconnect to the network.[104] The impact also depends on how well the policy mechanisms ensure competitive pricing for wholesale services in the event of the presence of a middle mile provider that may also be a last mile provider.[105]

Merit set up the REACH-3MC network as an open access network, where any provider can pay to connect to the network to offer services. Merit discussed its commitment to operating the REACH-3MC network in a transparent, carrier-neutral, nondiscriminatory manner to comply with the nondiscrimination and interconnection requirements of the BTOP grant.

ACD.net, Lynx, and TC3 are the project's three project participants (subrecipients), and all are broadband service providers. Each of these participants owns strands of fiber on segments of the seventy-two strand-count backbone to provide services in their respective service areas, and each has a different business model. TC3 is focusing on small commercial areas, like central business districts. It has three downtown businesses already connected. TC3 also seeks to provide services to residential customers. Lynx provides middle mile services, and serves primarily large, wholesale customers. It has positioned itself to build to large manufacturers or industrial parks. Lynx also works cooperatively with Merit on network maintenance. As of the site visit, Lynx had a presence at eighty-five interconnection points on the network backbone. In September 2013, Lynx was 70 percent lit and was pre-selling to last mile providers that would be providing services along the route. ACD.net is both a last mile and middle mile service provider. All providers act as demand aggregators for the REACH-3MC network as they engage local communities and municipalities to invest in broadband.

In addition to ACD.net, TC3, and Lynx, several providers expressed interest in offering services over the network. Merit, as the network operator, and Lynx, as a wholesale provider, will actively pursue additional providers to offer services over the network. Merit anticipates that the presence of additional providers, because of the successful implementation of the open access policy, will cause increased competition in areas served by ACD.net, TC3, and Lynx. Merit's strategic location of interconnection points along the REACH-3MC backbone allows third-party providers to design a redundant network topology of their own. Connect Michigan identified 151 last mile providers throughout the state. Lynx intends to serve 20 percent of these, and is halfway to this goal. Lynx

has signed fifteen agreements with last mile providers, including three since the end of the grant award period. Lynx believes its goals are attainable and may be surpassed.

Providers that are leveraging either the REACH-3MC physical infrastructure or the services offered over the infrastructure to reach customers in their service areas include the following:

- MiSpot, a Lynx customer, is a retail provider out of Pigeon, Michigan, offering 4G LTE fixed wireless broadband service to households and small businesses through thirty-nine active towers
- Sunrise Communications in Onaway, Michigan, leases dark fiber from Merit and interconnects with the REACH-3MC network in Hillsdale to provide service to households, businesses, and CAIs. It is looking to replace its copper lines with fiber. It will be able to offer customers 3 – 10 Mbps over fiber for what it costs them to offer 512 kbps – 3 Mbps over copper.
- Allband Communications Cooperative, based in Curran, Michigan, interconnects with Merit to support its Gigabit Passive Optical Network (GPON) fiber-to-the-home deployment.

## 3.3 Results

There were three major results of the Merit project observed by the evaluation study team:

- The REACH-3MC project supplied increased broadband capacity and speed to CAIs in Michigan. All of the CAIs connect to the network via a 1 Gbps link, and most of the institutions the evaluation study team visited can now subscribe to broadband speeds faster than they could with their previous connections. These faster speeds enable the use of broadband-dependent technologies to improve efficiencies and better serve the missions of the CAIs. The free on-net traffic promotes collaborations between members that can produce similar results. Section 2 provides descriptions of early impacts the evaluation study team observed.
- The REACH-3MC network provides these increased broadband speeds at lower prices than before the expansion of the Merit network. Before BTOP, the price of a 6 Mbps broadband subscription through Merit was $7,089 per year. After BTOP, it is $2,160. For a 100 Mbps subscription, the price has decreased from $78,104 to $36,000 per year.[106] Merit staff members reported that CAIs tended to put cost savings toward subscribing to faster bandwidth. For CAIs that were already Merit members, they left speeds open to the full 1 Gbps for a period of time to let members gauge the amount of bandwidth their users would consume free of speed limitations.
- The availability of lower priced middle mile bandwidth encourages the expansion of broadband service to businesses and residents in the service area. As of September 2013, Lynx had signed agreements with fifteen service providers. The results of these agreements are discussed in Section 2.2 and Section 3.2.

The longer-term impact of the Merit network will depend on several factors related to the results listed above:

- The impact of open access will depend on how well the practices and policies help to reduce the time, cost, and ease for last mile providers to interconnect to the network.[107] The use of the newly available broadband capacity will depend on the creativity and investment of local economic factors. The evaluation study team spoke with three service providers who were already making use of REACH-3MC to provide broadband service to customers, many of whom did not have access to reliable broadband networks previously. These providers expanded their businesses to accommodate improved business opportunities in the northern Lower Peninsula.
- Merit must maintain the reliability of the network over time. At present, Merit monitors the network and works with Lynx and other providers to address any issues that require maintenance. CAIs reported that Merit often informs them of network outages before the CAIs themselves notice an issue with their service, and they work diligently to restore service quickly

and with as little disruption as possible. Merit has been operating telecommunications networks for over forty years, and its successful record of working together with its members suggests that future network maintenance is well within its capabilities.

- The economic development impacts to the region as a whole will depend on how individuals and institutions use the increased broadband service. At the time of the site visit, CAIs and businesses were hopeful that the presence of robust, redundant broadband fiber would attract new businesses and open new possibilities for employment in tourism-dependent areas.

## 3.4 Sustainability

Merit is well positioned for project sustainability from both its longstanding relationships with its members and the structure of the project team, which provides for a broad base over which to spread operations and maintenance costs. Because of Merit's open access policies, participant organizations such as commercial providers also provide service over the network, and Merit's maintenance responsibilities extend to these organizations as well. As part of the transition from the build phase to the operational phase of the project, Merit has begun the process of selecting a firm to perform network maintenance. Merit has also set up a maintenance cost-sharing model to spread the cost of infrastructure upkeep among the four parties who participate in the grant.

## 3.5 Successful Tools, Techniques, and Strategies

This subsection describes successful techniques, tools, and strategies the grantee and interviewees identified. Successes and challenges described in earlier sections are not repeated here.

- Early in the grant application process, Merit sought out agreements with third-party providers with a presence in the state that could use the REACH-3MC network to serve additional CAIs, households, and businesses. To engage potential customers, Merit actively worked with local officials and citizens in the grant-funded service area to highlight BTOP and its importance as an economic and community-building tool.

- Merit has engineered connection points to minimize maintenance costs and service disruptions. Splice points at add/drop sites on the network design incorporate a "master" and "slave" splice case design. The "master" splice cases hold all fibers spliced off a backbone and onto a lateral. These fibers serve as general-purpose access for Merit. Each provider on a lateral has its own "slave" case with only its fibers that providers must maintain for themselves. This reduces the possibility of an unintended service disruption for one provider because of error on the part of another.

- Merit led the planning and engineering processes with assistance from ACD.net, TC3, and Lynx Network Group. These providers have knowledge and experience with designing and building networks in Michigan. The team worked together to determine optimal network routes and strategic placement of interconnection point locations along the route. The results of this collaborative effort was a network design that optimized long haul transport and short distance runs from an interconnection point that accommodates multiple third-party providers to build out the last mile. The design also allows for easy support of legacy technologies common among the smaller last mile providers in the northern part of Michigan's Lower Peninsula and the Upper Peninsula.

- Merit has provided the means for subscribers to "self-aggregate" their broadband subscriptions. For example, subscribers with multiple links to the network (multiple locations or dedicated lines to multiple building on one campus) can aggregate their bandwidth for billing purposes. These customers are treated as one subscriber, as is the bandwidth usage from all links. Some Merit members, including the Charlevoix Public Schools and the Cheboygan-Otsego-Presque Isle Intermediate School District have formed a consortium to share services and increase their

broadband purchasing power. These methods of self-aggregation allow Merit to promote broadband use at many locations simultaneously, while keeping management and overhead costs down.

- In general, current Merit members had a better idea of their bandwidth needs than new members did. This was due in part to the bandwidth management tools that Merit provided to its members, which allowed them to estimate the extent to which their needs had increased relative to past years. Merit worked with organizations that were already members to determine their need by leaving their connection open to the full 1 Gbps for one to two months. New members were provided with information through meetings and testimonials, as well as meetings with existing members to develop a bandwidth estimate based on their desired activities. It could take as much as six months to go from an initial meeting with a potential new member to the development of an implementation plan.

- When performing the environmental assessment, Merit found it most helpful to communicate early and often with officials at all levels of government and with permitting agencies, including railroads and utilities, to ensure all design contingencies were accounted for and a timely review could occur. To achieve this, Merit hired an employee who was in the field full time to monitor activities during the environmental assessment and construction. This ensured open lines of communication between the grantee's headquarters and field crews in remote areas of the state. Merit also worked directly with the State Historic Preservation Office (SHPO) to overcome state resource constraints that limited the responsiveness of the SHPO to a project as large as REACH-3MC.

## 3.6  Challenges

- Environmental assessment tasks were a significant impediment to rapid progress.
  - o The grant award period started on January 1, 2010. However, Merit was not notified of its Round 1 grant award until January 27. The timing of the grant award notification meant that Merit lost almost a month off the six-month timeline to complete the environmental assessment phase of the project.
  - o In mid-February, NTIA issued a Special Award Condition (SAC) stipulating environmental assessment requirements that were more extensive than what were presented in the Notice of Funds Availability (NOFA). NTIA held subsequent calls with Merit about the environmental assessment requirements included in the Special Award Conditions toward the end of February 2010. The additional requirements added about six to seven times the budgeted amount to perform the environmental assessment. Merit did not begin work on the environmental assessment until after issuance and clarification of the SAC requirements, so Merit effectively had to mobilize a team and perform the environmental assessment in four months.
  - o Merit's initial environmental assessments did not include contingencies for alternate routes and installation methods. For example, the initial environmental assessment contained very precise network routing and specific pole attachments with no alternate paths or poles described. This required subsequent amendments to be made when pole attachment rights could not be obtained as planned, or a proposed underground installation had to be relocated because it traversed an environmentally sensitive area.

# Section 4. Conclusions

The American Recovery and Reinvestment Act of 2009 (Recovery Act) instructed NTIA to implement BTOP to promote five core purposes:[108]

1. Provide access to broadband service to consumers residing in unserved areas of the country.
2. Provide improved access to broadband service to consumers residing in underserved areas of the country.
3. Provide broadband education, awareness, training, access, equipment, and support to:
   a. Schools, libraries, medical and healthcare providers, community colleges and other institutions of higher learning, and other community support organizations.
   b. Organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband services by vulnerable populations (e.g., low-income, unemployed, seniors).
   c. Job-creating strategic facilities located in state- or federally designated economic development zones.
4. Improve access to, and use of, broadband service by public safety agencies.
5. Stimulate the demand for broadband, economic growth, and job creation.

This section summarizes how Merit's implementation of BTOP has encouraged the fulfillment of the Recovery Act's goals.

## 4.1 Improve Access to Unserved and Underserved Areas of the Country

The first two goals of the Recovery Act encourage improved access for unserved and underserved areas:

- Provide access to broadband service to consumers residing in unserved areas of the country.
- Provide improved access to broadband service to consumers residing in underserved areas of the country.

The REACH-3MC project allowed Merit to accelerate plans to deliver improved broadband service to unserved and underserved areas of Michigan. As a nonprofit serving primarily educational institutions, Merit was limited in its pace of investments by the amount of operational funds it could divert into infrastructure investments. The BTOP grant allowed Merit to accelerate the pace of its service rollout to areas identified as underserved. As shown in Section 1, the area served by the Round 1 REACH-3MC grant had far fewer broadband options than other parts of the state. According to the June 2011 release of the NBM, 35 percent of the residents of Merit's Round 1 project had only one broadband service provider available to them or no broadband service at all. In contrast, in the rest of Michigan, only 19 percent of the population had a single broadband provider or no broadband service in their location. It should be noted that the rest of the state includes the Upper Peninsula of Michigan and other underserved areas that would later receive service because of Merit's Round 2 BTOP grant. Broadband subscribership rates were also lower in the Round 1 service area than in the rest of the state. Fifty-eight percent of the service area subscribed to an Internet service that had at least 768 kbps download speeds and 200 kbps upload speeds.[109] Nearly 63 percent of the state's household population subscribed to an Internet service with the same minimum thresholds.[110]

Because of the Round 1 BTOP grant, 154 CAIs connected to the Merit network. Merit teamed with Lynx, ACD.net, and TC3 to extend the benefits of the new broadband infrastructure beyond the nonprofit institutions Merit focuses on serving. In particular, Lynx provides access to third parties that seek to provide service in the underserved areas, and ACD.net is providing access at locations including the technology park in Hillsdale. MiSpot has made some progress in the community surrounding Houghton Lake Library, providing broadband service where it had not been available before. Charter reduced the price of its broadband connections and began offering shorter-term contracts in response to the Merit network and the entry of MiSpot into the market. The middle mile network also enabled Allband to provide services to 100 households that did not previously have service.

## 4.2 Broadband Education, Awareness, Training, Access, Equipment, and Support

Most closely aligned with PCC and SBA grants, the next Recovery Act goal is for grantees to provide broadband education, awareness, training, access, equipment, and support to:

1. Schools, libraries, medical and healthcare providers, community colleges and other institutions of higher learning, and other community support organizations.
2. Organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband services by vulnerable populations (e.g., low-income, unemployed, seniors).
3. Job-creating strategic facilities located in state- or federally designated economic development zones.

Many of the CAIs served by the REACH-3MC project are existing or former Merit members. The REACH-3MC project has allowed Merit to expand its service in that part of the broadband market, in addition to providing education, training, equipment, and support to libraries and healthcare providers.

Merit identified all of the potential customers. Two years ago it created a list of these CAIs and created regional offices across the state, each responsible for the CAIs in its geographic area. Merit invites members to town hall meetings, and then follows up with a services workshop, where local members and potential new members are brought together to discuss Merit's approach to serving CAIs. These meetings have been successful in recruiting new members. Merit has an advisory council that performs outreach. In addition to improved broadband infrastructure, Merit provides the following services:

- Professional development training and education to its members through webinars and in person events across the state.
- Advice to members about the best way to achieve their information technology goals, including information about Merit products and alternatives that are available through other providers.
- An awards program to recognize members for innovative uses of the network, meritorious service, and community building.
- A workshop that introduces the basics of fiber networking and develops ideas about how the institution could use a fiber connection to the Merit network.

Merit also works to expand the circle of Merit members. The benefits of being a Merit member include access to high-speed broadband at competitive rates, training, professional development, and other programs mentioned above, but also free on-network connectivity to other Merit members.

The Houghton Lake Public Library received public computers through MSU's PCC BTOP grant. It received funding for six computers, but carefully managed grant funds and was able to purchase

fourteen. The library sought this funding because it knew it would receive increased speed through the Merit CCI grant, and its older computers would not be able to take full advantage of the new fiber broadband connection. The library uses the computers for a variety of purposes, including services to schools and school-aged children, digital literacy classes for adults and seniors, and public access for online classes, social networking, and entertainment. Before the grant, the library reached its bandwidth limit, due in part to the large number of portable devices brought by patrons. Connecting to the REACH-3MC network also allowed the library to install VoIP with voice mail and enhanced call management features.

## 4.3 Public Safety Agencies

The fourth goal of the Recovery Act is to improve access to, and use of, broadband service by public safety agencies. As described in Section 2 of this report, the Merit project connected five police and sheriff's offices, and two local fire departments. The State of Michigan requires separate lines for their public safety information-sharing network, and these are still operating over dedicated T1 lines. Section 2 describes the public safety impacts the evaluation study team observed.

The Manistee County Sheriff would like to install broadband connections in emergency vehicles. The key issue is the ability to connect remotely, such as through a Wi-Fi connection. The response of local carriers to the availability of the middle mile infrastructure will be key to obtaining this type of coverage. Merit expects the presence of the REACH-3MC network to increase the number of providers in rural areas and to increase the quality of service. There have been some indications that this is already taking place. Other providers have begun installing fiber-optic cable in the area, in a process described as "non-stop."

## 4.4 Demand for Broadband, Economic Growth, and Job Creation

The final Recovery Act goal is to stimulate the demand for broadband, economic growth, and job creation. Most of the CAIs participating in the grant were already broadband users, but had lower levels of connectivity than the REACH-3MC network provided.

Most of the residential customers in the rural northern areas of Michigan's Lower Peninsula have either cable or DSL service, and some still have dial-up. Merit has made a concerted effort to engage leaders in these rural areas to educate these communities on the benefits of broadband through fiber in an effort to justify an investment in deploying fiber to serve sparsely populated, rural areas. Because of the Merit project, providers such as Allband and MiSpot have increased broadband availability in rural areas, and plans include expansion of these efforts in the upcoming years.

Broadband is a key enabler of economic growth, especially in the northern part of the Lower Peninsula. Many areas in northern Michigan are dependent on the tourist industry, or have large populations who live there only in the summer. The general manager of MiSpot, which provides wireless service to customers in this area, reported that increased broadband service can keep summer residents in the area longer, if they are able to do work remotely because of the service. Broadband is also seen as a key differentiator for communities that seek to adapt and grow in a new economic environment. Many of the smaller communities in the Lower Peninsula were connected to manufacturing industries that have waned in importance. Broadband is a key utility that allows other utilities and resources to attract potential new businesses. For example, one challenge of the City of Hillsdale and its Board of Public Utilities is that power generation for the city was built for larger loads than are currently placed on the system. Recently, manufacturing firms have left the region, freeing up generator capacity. The City of Hillsdale seeks to attract a data center that could take advantage of available generator capacity. Hillsdale sees broadband as essential to regaining its economic footing. Improved broadband connectivity may also help to stem the departure of businesses and residents that remain in the local community. Although there are

some businesses that are not reliant on broadband technology, most are increasingly heavy users of broadband connectivity, and keeping up with bandwidth needs is one retention tool available to local economic development authorities.

# Section 5. Next Steps for the Evaluation Study

In early 2014, ASR will deliver *Interim Report 2* to NTIA. This report will include a summary of the site visits to twelve CCI projects. It will also include a summary of the second round of site visits to the fifteen PCC and SBA grants.

For the CCI projects, *Interim Report 2* will summarize the activities underway by twelve CCI grantees and the social and economic impacts of these projects. For the PCC and SBA projects, *Interim Report 2* will provide an update to and refinement of the analysis presented in *Interim Report 1*.

In September 2014, ASR will deliver a *Final Report* that quantitatively and qualitatively assesses the economic and social impact of BTOP grants (including CCI, PCC, and SBA grants). The centerpiece of the *Final Report* will be an assessment of how and to what extent BTOP grant awards have achieved economic and social benefits in areas served by the grantees. To the extent that such information is available, ASR will use results from studies performed by the grantees to round out the conclusions presented.

# Notes

[1] National Telecommunications and Information Administration, *Broadband Technology Opportunities Program (BTOP) 16th Quarterly Program Status Report*, 2013, http://www.ntia.doc.gov/files/ntia/publications/ntia_btop_16th_quarterly_report.pdf.

[2] National Telecommunications and Information Administration, "About," *BroadbandUSA: Connecting America's Communities* (Washington, DC, June 11, 2012), http://www2.ntia.doc.gov/about.

[3] The Notice of Funds Availability (NOFA) includes the following definitions:

- Last mile project – any infrastructure project the predominant purpose of which is to provide broadband service to end users or enduser devices (including households, businesses, community anchor institutions, public safety entities, and critical community facilities).
- Middle mile project – a broadband infrastructure project that does not predominantly provide broadband service to end users or to end-user devices, and may include interoffice transport, backhaul, Internet connectivity, or special access.

National Telecommunications and Information Administration, "Broadband Initiatives Program; Broadband Technology Opportunities Program Notice" (Washington, D.C., 2009), http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf.

[4] National Telecommunications and Information Administration, "Statement of Work for Broadband Technology Opportunities Program (BTOP) Evaluation Study," July 26, 2010, 6.

[5] ASR Analytics, *Progress towards BTOP Goals: Interim Report on PCC and SBA Case Studies*, *Broadband Technology Opportunities Program Evaluation Study (Order Number D10PD18645)* (Potomac, MD, 2012), http://www.ntia.doc.gov/report/2012/progress-towards-btop-goals-interim-report-pcc-and-sba-case-studies.

[6] Merit Network Inc., "About Merit Network," June 08, 2012, http://www.merit.edu/about/.

[7] Merit Network Inc., "Professional IT Services for Merit Community," June 08, 2012, http://www.merit.edu/services/.

[8] National Telecommunications and Information Administration, *Merit Network, Inc. REACH Michigan Middle Mile Collaborative Fact Sheet*, *BroadbandUSA: Connecting America's Communities*, January 2011, http://www2.ntia.doc.gov/files/grantees/Merit_Network_factsheet_LES_011910.pdf.

[9] National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12" (Washington, DC: Distributed by National Telecommunications and Information Administration, 2013).

[10] National Telecommunications and Information Administration, *Merit Network, Inc. REACH Michigan Middle Mile Collaborative Fact Sheet*.

[11] According to the grantee, these numbers may underrepresent the number of individual CAIs connected, as many pass along service to other CAIs. In addition, several Merit members that were connected to fiber previously had been receiving broadband but were limited by Merit's backhaul. This was the case with the CAIs in Hillsdale—the City, BPU, and College. They are not part of the fifty-five new direct connections, but are still observing impacts.

[12] Sixteen of the connected schools (K-12) reported by Merit could not be matched to the public data set. These institutions were added to the service area and state totals. Seven of the connected schools (K-12) reported by Merit represent multiple institutions or are located at addresses shared with other institutions. The evaluation study team identified these reported institutions as multiple institutions, adding eight to the reported total of schools (K-12). Two of the connected postsecondary institutions reported by Merit could not be matched to the public data set. These institutions were added to the service area and state totals. Fourteen of the connected postsecondary institutions reported by Merit are satellite campuses or locations; one is an alumni association; and two are partnership programs. The evaluation study team treated the entire institution as served where possible, and added institutions to the service area and state totals where necessary. One of the connected public safety institutions identified as a police department could not be matched to the public data set. This institution was added to the service area and state totals.

Centers for Medicare & Medicaid Studies, "National Plan and Provider Enumeration System (NPPES)" (Washington, DC, July 2013), http://nppes.viva-it.com/NPI_Files.html; National Center for Education Statistics, "Elementary/Secondary Information System (ELSi)" (Washington, DC, August 15, 2013), https://nces.ed.gov/ccd/elsi/; National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)" (Washington, DC, August 15, 2013), https://nces.ed.gov/ipeds/; National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12"; United States Department of Justice. Office of Justice Programs. Bureau of Justice Statistics, "Census of State and Local Law Enforcement Agencies (CSLLEA), 2008," *Directory of Law Enforcement Agencies Series* (Ann Arbor, MI: Inter-university Consortium for Political and Social Research, August 03, 2011), doi:10.3886/ICPSR27681.v1; United States Fire Administration, "National Fire Department Census Database," August 08, 2013, http://apps.usfa.fema.gov/census/.

[13] National Telecommunications and Information Administration, *Merit Network, Inc. REACH Michigan Middle Mile Collaborative Fact Sheet*.

[14] National Telecommunications and Information Administration, *Merit Network, Inc. REACH Michigan Middle Mile Collaborative Fact Sheet*.

[15] Merit Network Inc., *REACH Michigan Middle Mile Collaborative Application Part 1*, *BroadbandUSA: Connecting America's Communities*, August 18, 2009, http://www2.ntia.doc.gov/files/grantees/meritnetwork1_application_part1.pdf.

[16] United States Census Bureau, "2007-2011 ACS 5-Year Summary File," *American Community Survey* (Washington, DC, December 06, 2012), http://www.census.gov/acs/www/data_documentation/2011_release/.

[17] United States Census Bureau, "2007-2011 ACS 5-Year Summary File."

[18] United States Census Bureau, "2007-2011 ACS 5-Year Summary File."

[19] United States Census Bureau, "2007-2011 ACS 5-Year Summary File."

[20] National Telecommunications and Information Administration, "State Broadband Initiative June 30, 2011" (Washington, D.C.: United States Department of Commerce, 2011), http://www2.ntia.doc.gov/Jun-2011-datasets.

[21] National Telecommunications and Information Administration, "State Broadband Initiative June 30, 2011."

[22] FCC Form 477 data includes information at the census tract level on the population that subscribes to broadband using the following speed thresholds: at least 768 kbps download speed and at least 200 kbps upload speed. Because of this limitation, ASR is not able to filter for subscribers with download speeds of at least 3 Mbps and upload speeds of at least 768 kbps.

[23] Federal Communications Commission, "Local Telephone Competition and Broadband Deployment Form 477," June 2012, http://transition.fcc.gov/wcb/iatd/comp.html.

[24] Other Community Support CAIs include local government agencies and workforce development training centers. Three of the four medical CAIs in the table are Community Mental Health (CMH) agencies.

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- Middle: lowest grade offered is in fourth through seventh grades and highest grade offered is in fourth through ninth grades
- High: lowest graded offered is in seventh through twelfth grades and highest grade offered is twelfth grade
- Other: grades offered do not follow the primary, middle, or high school level configurations, or the school does not have a grade system
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3. If two full-time employees each worked 520 hours (1,040 hours) for the quarter and another half-time employee worked 260 hours, the Total Hours for the three employees is 1300 (520 + 520 + 260 = 1300).
4. Divide 1300 by 520 to equal 2.5 Recovery funded jobs during that quarter.

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- City, Midsize: Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000
- City, Small: Territory inside an urbanized area and inside a principal city with population less than 100,000

- Suburb, Large: Territory outside a principal city and inside an urbanized area with population of 250,000 or more
- Suburb, Midsize: Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000
- Suburb, Small: Territory outside a principal city and inside an urbanized area with population less than 100,000
- Town, Fringe: Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area
- Town, Distant: Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area
- Town, Remote: Territory inside an urban cluster that is more than 35 miles from an urbanized area
- Rural, Fringe: Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster
- Rural, Distant: Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster
- Rural, Remote: Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster
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# Glossary

| Acronym | Definition |
|---|---|
| APR | Annual Performance Progress Report |
| BPU | Board of Public Utilities |
| BTOP | Broadband Technology Opportunities Program |
| CAI | Community Anchor Institution |
| CCI | Comprehensive Community Infrastructure |
| CPS | Charlevoix Public Schools |
| EHR | Electronic Health Records |
| EMR | Electronic Medical Records |
| EMS | Emergency Medical Services |
| FAFSA | Free Application for Federal Student Aid |
| FCC | Federal Communications Commission |
| FTTP | Fiber-to-the-Premise |
| GPON | Gigabit Passive Optical Network |
| ILEC | Incumbent Local Exchange Carrier |
| IMLS | Institute of Museum and Library Services |
| IRU | Indefeasible Rights of Use |
| ISD | Intermediate School District |
| ISP | Internet Service Provider |
| IT | Information Technology |
| LAN | Local Area Network |
| LMC | Lake Michigan College |
| LMS | Learning Management System |
| MAC | Merit Advisory Council |
| MOU | Memorandum of Understanding |
| MSU | Michigan State University |
| NBM | National Broadband Map |
| NCCMH | North Country Community Mental Health |
| NOFA | Notice of Funds Availability |
| NPPES | National Plan and Provider Enumeration System |
| NSF | National Science Foundation |
| NSFNET | National Science Foundation Network |

| Acronym | Definition |
|---|---|
| NTIA | National Telecommunications and Information Administration |
| PCC | Public Computer Centers |
| PON | Passive Optical Networking |
| PPR | Quarterly Performance Progress Report |
| QSC | Qualified Service Checklist |
| REACH-3MC | REACH Michigan Middle Mile Collaborative |
| Recovery Act | American Recovery and Reinvestment Act of 2009 |
| RFI | Request for Information |
| SAC | Special Award Condition |
| SBA | Sustainable Broadband Adoption |
| SCMW | South Central Michigan Works! |
| SHPO | State Historic Preservation Office |
| TOD | Technology Overlay District |
| UMBS | University of Michigan Biological Station |
| VoIP | Voice over Internet Protocol |
| VPN | Virtual Private Network |
| WAN | Wide Area Network |
| WDM-PON | Wavelength Division Multiplexing Passive Optical Networking |

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