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THE SMART RURAL COMMUNITY

By Jesse Ward, Industry and Policy Analysis Manager

NTCA THE RURAL BROADBAND ASSOCIATION

4121 Wilson Blvd, Suite 1000
Arlington, VA 22203
703-351-2000
www.ntca.org

The Smart Rural Community

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Executive Summary

A smart rural community relies on broadband networks to enable a series of applications that the community can leverage for innovative economic development and commerce, top-notch education, first-rate health care, cutting-edge government services, enhanced security and more efficient utilities use. These functions are increasingly important as the imperative to compete in a global marketplace increases.

Rural areas are often far away from the types of resources that are available in urban areas. Schools, health care providers, public safety institutions and commercial entities, however, can be positioned to reap the benefits of a smart rural community. This paper will explain the economic and societal gains enabled by broadband, and describe how different rural service providers and the communities they serve have embraced the challenges and opportunities of new technology.

- Schools can engage in distance learning to offer courses that would be otherwise unavailable. The Northwest Minnesota Special Access, a consortium of rural telecommunications providers, connects 126 schools and 43 libraries in the state, enabling students to take advanced placement, foreign language and other specialty courses.

- Remote medical diagnostics and monitoring enables quicker, more economically efficient access to specialists. Smith County Memorial Hospital in Smith Center, Kan., uses broadband to consult with specialists at larger regional hospitals.

- Advances in agricultural technology enable efficient crop management, leading to higher yields and less waste. Swanberg Farms in Lyford, Texas, relies upon broadband to monitor commodity prices and weather forecasts.

- Public safety officers can deploy personnel and resources more effectively. Chattanooga, Tenn., police officers can investigate crime scenes with 3-D imaging, freeing up deployment of officers who would otherwise be required to remain on-scene.

- Governments can interact with citizens with greater ease, leading to better civil management and administration. Montana enables livestock owners to record branding information online, and recent data demonstrates that more than 60% of owners are taking advantage of online capabilities.

- Public utilities can offer consumers the unprecedented ability to control usage, increase efficiencies, and preserve resources and spending. Somerset, Kan., is embarking on an ambitious project that will use broadband-enabled technologies to increase water production from 10 million to 16 million gallons per day.

The presence of a broadband network, however, does not itself complete the smart rural community. Rather, the combined actions of service providers, applications developers, manufacturers and users who adopt and utilize the services create opportunities for community growth and viability. This paper illustrates the steps many rural communities have taken, and encourages exploration of opportunities by other communities and interests.

Introduction

Communities of all types compete in a global economy. Communities that possess the ability to leverage and disseminate skills and knowledge provide their citizens with the necessary tools to succeed. Inadequate access to information or an inability to leverage it can have devastating consequences.

Communities need to become and remain "smart;" successful participation in a global marketplace demands it. For rural communities, the challenges to becoming and remaining smart are not trivial. Meeting and overcoming those tests require a coordinated effort from civic and business leaders.

What Is a Smart Rural Community?

A smart rural community uses broadband networks to enable a series of applications that the community can leverage for innovative economic development and commerce, top-notch education, first-rate health care, cutting-edge government services, enhanced security and more efficient utility use. Broadband facilitates greater interconnection for intra- and intercommunity resources. Moreover, broadband enables intelligent networks, making communities smarter, more efficient and better able to prepare their citizens to participate in the global economy.

Broadband networks that are currently being built by rural telephone companies are economic engines for the entire community. These networks are enabling a wide range of applications that meet consumer, business, government and institutional needs.

Broadband networks are the foundation for smart communities; however, the presence of broadband infrastructure by itself does not create *de facto* a smart community. Rather, broadband is a tool that local stakeholders can use collectively to develop and achieve community goals.

This paper explores how broadband technology is revolutionizing a variety of vertical industries and enabling innovative applications. In many instances, there is a local, collaborative approach to improving the lives of citizens and sustaining the prosperity of the community.

Education

Broadband can enable greater distribution and use of educational resources. Throughout the nation, there is a scarcity of capable math and science teachers[1] and an unbalanced distribution of K–12 teachers among geographic locations.[2] Today, 40% of U.S. public school districts require online learning resources because certified teachers are not available for traditional face-to-face instruction in those districts—an increase of 38% since 2006.[3] In the K–12 environment this is especially true for advanced placement courses, special education, credit recovery programs, and electives such as foreign languages and sciences. Post-secondary instruction often is limited or nonexistent in rural areas.

The smart rural community should investigate virtual instruction delivered via broadband to fill the gap between educational needs and availability. A 2010 U.S. Department Education report concludes that purely online learning and "blended" programs, which incorporate face-to-face instruction, are academically effective, resulting in student performance that is better than traditional face-to-face instruction.[4]

Broadband extends the reach of instructors and creates economies of scale. For rural citizens who live far from the nearest town, online learning is a lifeline.[5] A rural student may not be able to relocate to enroll in a college or university, or may find a two-hour bus ride to school a hardship; however, with a broadband connection, the student can learn a foreign language, take an advanced placement Biology course or enroll in a university class. Broadband access can provide the community with continuing education opportunities, including job and technical training to support a knowledge workforce.

Further, the smart rural community should strive to create an interactive, collaborative and customized learning environment that engages today's student and appeals to his unique

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[1] Ingersoll, Richard M. and David Perda, *The Mathematics and Science Teacher Shortage: Fact and Myth*, The Consortium for Policy Research in Education (March 2009), CPRE Research Report #RR62, p. 35-38, http://www.cpre.org/images/stories/cpre_pdfs/math%20science%20shortage%20paper%20march%202009%20final.pdf.

[2] Picciano, Ph.D., Anthony G. and Jeff Seaman, Ph.D., *K-12 Online Learning: A 2008 Follow-up of the Survey of U.S. School District Administrators*, The Sloan Consortium (January 2009), p. 5, http://sloanconsortium.org/sites/default/files/k-12_online_learning_2008.pdf.

[3] *K–12 Online Learning: A Smart Investment NOW More Than Ever*, iNACOL International Association for K–12 Online Learning, http://www.inacol.org/research/docs/iNACOL_NowMorethanEver-lr.pdf.

[4] Means, Barbara and Yukie Toyam, et al., "*Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*," U.S. Department of Education, Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service (Revised September 2010), p. xiv-xv, http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf.

[5] *Ibid.* 2, p. 1.

learning style and needs. The smart rural community should attempt to incorporate the latest digital technology within and outside of the traditional classroom to prepare students to participate in the global economy. Multimedia instruction addresses all types of learners—auditory, read/write, visual and kinesthetic, those who learn by doing. Students also have a clear preference for learning that is highly personalized, untethered, socially based and digitally rich.[6]

Access to mobile technology has more than tripled among high school students in the past three years, and K–12 students overwhelmingly report that their "ultimate school" would allow them to use mobile applications.[7] In preparation for student demand, content providers such as Discovery Education[8] and Blackboard[9] have developed mobile applications and tablet-optimized versions of their Web-based learning platforms.

In addition to teaching tools, broadband also enables administrative collaboration. Electronic data can be shared between parents, teachers, administrators and students in real time, enabling a dynamic and responsive educational process. Institutions can collaborate and learn from each other when sharing data. Student scores (stripped of personal identification data) can be recorded to allow teachers and administrators to share best practices, content and strategies to improve student performance.

Rural telecommunications providers have a long history of providing innovative learning platforms within their communities. Based in Halstad, Minn., independent telecommunications cooperative Halstad Telephone Co. (HTC) maintains an Ethernet, fiber-based network that provides broadband service to each of the four K–12 schools in its territory.[10] HTC is part of the Northwest Minnesota Special Access, a consortium of 18 rural telephone companies that connects 126 schools and 43 libraries in the state.[11] Students often use a remote video connection to take advanced placement, foreign language and other specialty courses from a teacher located in another facility. The network is linked to the University of Minnesota, Crookston, enabling high school students to enroll in college courses via a video conferencing application.

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[6] *Creating Our Future: Students Speak Up About Their Vision for 21st Century Learning*, Speak Up 2009, National Findings, K–12 Student and Parents (March 2010), p. 25, http://www.tomorrow.org/speakup/pdfs/SU09NationalFindingsStudents&Parents.pdf.

[7] *Ibid*., p. 8-10.

[8] Tour Discovery Education on the iPad, Discovery Education, http://www.discoveryeducation.com/ipad/.

[9] Blackboard Mobile, http://www.blackboard.com/Platforms/Mobile/Overview.aspx.

[10] Ward, Jesse, "IP: The Future of Education," *The New Edge*, NTCA, http://www.ntca.org/new-edge/epapers/the-future-of-education-interactivity-and-communication.

[11] NWMNSA FAQ's, http://www.nwmnsa.com/faq/index.php?op=aboutnwmnsa.

Although the network has been in place for many years, HTC recently observed an exponential increase in online activity. In 2010, HTC arranged provision of Discovery Education service to its four local K–12 schools at the company's expense for one year.[12] Under the terms of the arrangement, instructors and students have access to Discovery Education's multimedia and interactive content within the school building. Content includes audio files, images and videos, as well as interactive elements such as online quizzes, educational games, and math and science lab simulations. The rural communications provider reports that the various school systems engaged in this endeavor each have a 6 Mbps to 30 Mbps symmetrical connection, and due to the popularity of multimedia content, the various capacities are maxed out at least once per day.[13] HTC also stated that combined with the increasing use of tablets, it expects many schools to double their broadband speed requirements within the next two years. [14]

Nex-Tech, a rural communications provider located in Hays, Kan., provides a fiber backbone and video equipment to support Interactive Television Networks Inc. (ITVN).[15] ITVN is a shared network utilized by the local primary and secondary schools. The resource enables students to learn from teachers located in a different location, and allows the schools to share curriculum and spread the overhead costs among participants.

Nex-Tech also provides more than 150 free wireless broadband hotspots throughout its service territory, at local businesses and facilities such as the airport, city hall, museums coffee shops, restaurants and teen centers.[16] When the municipal government was faced with substantial budget cuts, Nex-Tech offered free, wired broadband connectivity and wireless Internet access to its local libraries.[17] This infrastructure enables local citizens to connect with the online world. Although individual student usage from home may be preferred, the local library can be an important online access point for students who might not have a home broadband connection.

In addition, Nex-Tech established a partnership with its local higher education institution, Fort Hays University, to develop a set of mobile applications for student access on Blackberry, Android and Apple iOS mobile devices.[18] The apps enable professors to post

[12] Information obtained from Halstad Telephone Co., March 28, 2012.

[13] *Ibid.*

[14] *Ibid.*

[15] Interview with Jeff Wick, chief operating officer, Nex-Tech, March 8, 2012.

[16] Wi-Fi Locations, Nex-Tech, http://www.nex-tech.com/Residential/Internet/WiFiLocations/WiFiList.aspx.

[17] *Ibid*. 15.

[18] "FHSU Joins Nex-Tech and Nex-Tech Wireless to Create Customized Smartphone Applications," Nex-Tech Wireless, http://www.nex-techwireless.com/news.aspx?post=233.

curriculum and allow students to review the campus map, enroll in courses, watch videos and interact with campus staff. Nex-Tech and Fort Hays University plan to develop the mobile platform further,[19] and by 2013, to host a student mobile application contest. Nex-Tech intends to create broad submission categories to encourage student innovation. Apps could be designed to enable the user to interact with the university or improve his experience with the local community. Apps also will be accepted that are targeted at local agriculture, businesses or other users.

Headquartered in Spring Grove, Minn., rural provider Spring Grove Communications (SGC) enables its citizens to learn on cutting-edge technology devices. SGC partnered with its local school district to outfit students with the latest laptops and tablets.[20] Apple iPads are used in all of the elementary classrooms, and every seventh through 12th grader has an Apple MacBook Air available to him during the school day. If a student wishes to take home a MacBook Air, he has the option of renting one for $15 a month. Many of the families renting laptops have never had a computer in their home. The program engages students on a dynamic, digital online platform, providing for learning anytime and anywhere. It also is educating students and teachers alike about how to use this technology and the importance of broadband in today's economy.

In addition to the student aspect of education innovation, virtual learning is a driver of economic development for small, rural towns. Under the traditional education system, a teacher is limited to open positions within driving distance of her home. With virtual education, a teacher residing in a rural area is able to teach from home and reach students across the state, district lines or the globe.

Eleutian Technology is an online language instruction firm that teaches English as a second language to students around the world using real-time video conferencing.[21] The company offers one-on-one or group tutoring sessions between internationally located students and certified U.S. schoolteachers who are native English speakers. Customers include public education systems and schools throughout the world, as well as global corporations and organizations.

Initially headquartered in Ten Sleep, Wyo., Eleutian's management has a prestigious history with firms such as Microsoft, Intel and Korea Telecom. When the company was in

[19] *Ibid*. 15.

[20] Information obtained from Craig Otterness, general manager/chief executive officer, Spring Grove Communications, April 2, 2012.

[21] Eleutian Technology: The Global Leader in Online English Teaching, http://www.eleutian.com/company-info/company-info-overview/.

its initial startup phase, it evaluated locations based upon affordable office space, access to teachers and access to the Internet backbone, which would allow its teachers to communicate with their international students. Ten Sleep School, a K–12 campus, quickly stepped up and agreed to temporarily house the company.[22] From these humble beginnings, Eleutian Technology today is composed of nine teaching-centers throughout the Western United States that operate 24 hours a day, 7 days a week.[23] As the largest new job creator in the region, Eleutian employs more than 400 certified U.S. schoolteachers.[24] In September 2011, the company outgrew its Ten Sleep building and re-located its headquarters just down the road in Cody, Wyo.[25]

For Eleutian, the core of its business rests on its robust broadband connectivity. Headquartered in Basin, Wyo., Tri-County Telephone (TCT) maintains a cutting-edge broadband network, with fiber to the premises in Ten Sleep and Powell, Wyo., and fiber to the node in surrounding areas. TCT's fiber network enables Eleutian to provide an interactive learning experience with no delays in videoconferencing capability.[26]

Top-notch education is vital to creating a competitive knowledge worker. The smart rural community understands that its citizens need access to a physical or virtual higher education institution that provides continual learning opportunities, including job and technology training. The smart rural community also understands that in order to prepare its students for today's broadband-based economy, it must investigate and strive to implement smart technology within the primary and secondary school system.

Learning is a dynamic activity that requires flexible access to content and instruction any time, and from any location, including in the traditional school building, the user's home and mobile locations. As an added benefit, this same broadband infrastructure can provide new career and business opportunities for the smart community's citizens.

Health Care

Broadband-enabled technologies can relieve some of the increasing pressure the health care industry faces. Health care costs are rising and straining available resources.

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[22] Croft, Patrick, "Bridging the Divide: TCT Connects Asian Students with U.S. Teachers," *The Exchange*, NTCA, (February/March 2010), http://www.ntca.org/images/stories/Documents/Publications/Exchange/NTCAFebMar10Exchange.pdf.

[23] *Ibid*. 21.

[24] Information obtained from Kent Holiday, president, Eleutian Technology, March 30, 2012.

[25] *Ibid*. 21.

[26] *Ibid*. 22.

Currently, the United States spends more on health care than any other developed nation,[27] and that trend is expected to continue as the population ages. By 2040 there will be twice as many Americans over age 65 as today.[28] Chronic conditions, which account for 75% of nation's health care costs, are increasing across all ages.[29]

People living in rural areas face additional challenges. Rural Americans experience more chronic conditions such as diabetes and heart disease than their urban and suburban counterparts.[30] Studies indicate that rural citizens also experience greater difficulty accessing quality health care.[31] As a whole, the country is expected to have a shortage of tens of thousands of physicians by 2020.[32]

Faced with these challenges, the smart rural community should investigate the use of broadband to bridge the gap between health care availability and rural patients' needs. Broadband-enabled solutions, usually grouped under the term health information technology (HIT), can assist health care practitioners as they strive to serve patients more effectively and efficiently. HIT is an overarching term that includes electronic billing and scheduling systems, the use of electronic health records (EHRs) and automated processes for clinical care.[33]

Many rural residents visit a variety of local health care providers and also travel to urban areas for treatment. Therefore, it is important that their health information follows them

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[27] Organisation for Economic Co-operation and Economic Development, OECD Health Data 2011 (June 2010), http://www.oecd.org/document/16/0,3343,en_2649_34631_2085200_1_1_1_1,00.html.

[28] Passel, Jeffrey S., and D'Vera Cohn, *U.S. Population Projections: 2005-2050*, Pew Research Center (February 11, 2008), p. 20, http://pewhispanic.org/reports/report.php?ReportID=85.

[29] Federal Communications Commission, *Connecting America: The National Broadband Plan* (March 2010), p. 199, http://download.broadband.gov/plan/national-broadband-plan.pdf. Citing Shin-Yi Wu & Anthony Green, RAND Corp., *Projection of Chronic Illness Prevalence and Cost Inflation* (2000).

[30] United Health Center for Health Reform and Modernization, *Modernizing Healthcare: Coverage, Quality and Innovation*, Working Paper 6 (July 2011), http://www.unitedhealthgroup.com/hrm/UNH_WorkingPaper6.pdf.

[31] Although 19% of the U.S. population lives in rural areas (2010 Census Urban and Rural Classification and Urban Area Criteria, United States Census Bureau, http://www.census.gov/geo/www/ua/2010urbanruralclass.html), less than 9% of physicians practice there (Larry D. Gamm & Linnae L. Hutchison, et al., *Rural Healthy People 2010: A Companion Document to Healthy People 2010, Volume 1*, College Station, Texas: The Texas A&M University System Health Science Center, School of Rural Public Health, Southwest Rural Health Research Center, p. 46, http://srph.tamhsc.edu/centers/rhp2010/Volume1.pdf. Citing G.E Barley, & C.B. Reeves, et al, "Characteristics of and Issues Faced by Rural Female Physicians," *Journal of Rural Health* 17(3) (2001), p. 251-258).

[32] *Ibid*. 29, p.199. Citing Health Resources & Services Administration, U.S. Department of Health & Human Services, *The Physician Workforce: Projections and Research into Current Issues Affecting Supply and Demand* (2008); Michael J. Dill & Edward S. Salsberg, Association of American Medical Colleges, *The Complexities of Physician Supply and Demand: Projections Through 2025* (2008), p. 6 (estimating a shortage of 124,000 physicians by 2025), https://members.aamc.org/eweb/DynamicPage.aspx?webcode=PubByTitle&Letter=T.

[33] For more on HIT, see 29, p. 200. Also see The Office of the National Coordinator for Health Information Technology, Department of Health and Human Services, http://healthit.hhs.gov/portal/server.pt/community/healthit_hhs_gov__home/1204.

across care settings via their EHRs. Greater integration of patient information can improve the ability of health care providers to serve patients by enabling multiple doctors, clinics and facilities to access patients' prior health history and coordinate care more effectively.

A subset of HIT, telemedicine refers to the remote delivery of health care via technology for the diagnosis and treatment of an illness or injury. Telemedicine encompasses a variety of applications and services. For example, remote patient monitoring devices electronically collect and send biometric patient information to health care providers; "store and forward" technologies e-transmit pre-recorded videos and digital files such as X-rays and photos between technicians, specialists or primary care providers; and interactive applications enable patients and practitioners to communicate in real time via voice and video sessions.

Telemedicine also is expanding beyond stationary brick-and-mortar institutions. Headquartered in Phoenix, Ariz., Lifebot has commercialized Disaster Relief and Emergency Medical Services (DREAMS), an ambulance-based telemedicine system that enables real-time advanced communications between emergency medical personnel and emergency rooms (ERs). DREAMS, also known as a "Super Ambulance" system, enables live transmission of voice and video, in addition to the patient's EHR and prioritized patient physiological data such as an electrocardiogram, ultrasound, blood gases, blood pressure and more.[34] The system includes a touch screen panel and portable user interface, roof-mounted cameras, headset communications, bar code readers for scanning supplies and a card scanner.[35] The ER doctor has the ability to control the cameras and some of the health devices remotely.[36] The system was used successfully in a six-year trial in Liberty County, Texas.[37] It holds great promise for emergency medical services, and telemedicine diagnosis and treatment between health care facilities.

In many cases, telemedicine has been proven to be more effective than traditional medical care. The Mayo Clinic, a worldwide leader in medical care, research and education, has developed a telemedicine program for the remote treatment of stroke patients. Referred to as "telestroke care,"[38] it includes a vascular neurologist located in a hub hospital who uses a smartphone, teleradiology applications and real-time video to remotely diagnose and treat

[34] *Ibid*.

[35] White, Dan, "DREAMS Revolutionizes Communications Between ER and Ambulance," Ems1.com (November 16, 2011), http://www.lifebot.us.com/news/ems1-com-dreams-revolutionizes-communication-between-er-and-ambulance/.

[36] *Ibid*.

[37] *Ibid*.

[38] Stroke Telemedicine, Mayo Clinic, http://www.mayoclinic.org/stroke-telemedicine/.

the patient.[39] Roughly 135 million people, or 45% of Americans, do not have access to primary stroke centers within 60 minutes of their homes.[40] A 2010 study followed two primary hub stroke centers—Mayo Clinic in Arizona and University of California, San Diego—and six rural "spoke" hospitals. The study found that compared with telephone consultations, telemedicine evaluation of stroke patients results in more accurate diagnoses, better emergency decision-making, fewer complications and encouraging long-term outcomes.[41] Further, a 2011 study found that telestroke care is cost-effective for rural hospitals that do not have an around-the-clock neurologist or stroke expert on staff.[42]

Rural telecommunications providers are a vital component of telemedicine services, providing network connectivity for facilities, devices and applications. Madison Telephone Co., located in Stauton, Ill., initiated a community partnership project with its local rural health care provider.[43] Community Memorial Hospital transfers digital images in order to receive remote diagnostic services from larger hospitals and clinics in St. Louis and Springfield, Illinois. The rural health care facility was interested in upgrading its radiology services, and installed a new 64-slice CT scanner that would produce significantly larger files for transmission via broadband connectivity and remote analysis. Although patients would benefit greatly from this technology, the hospital was concerned about its bandwidth limitations. Relying upon a shared T-1 circuit used by other public facilities, the hospital was already experiencing disruptive latency in its data transmissions. In December 2008, Madison Telephone worked in conjunction with the hospital to install fiber optic cable. The new fiber network enables the hospital to expedite the transfer of images and diagnostic information. Further, the network will allow the hospital to expand and adopt new telemedicine solutions.

In western Kansas, rural telecommunications provider Nex-Tech provides broadband services to 11 hospitals and 14 rural clinics.[44] These health care facilities utilize the broadband connection for a number of applications that are critical to patient care

[39] "Telemedicine Leads to Better Stroke Evaluations in Rural Areas," Mayo Clinic, (March 17, 2010), http://www.mayoclinic.org/news2010-sct/5704.html.

[40] *Ibid*.

[41] *Ibid*.

[42] "Good News for Rural Stroke Patients: Telestroke Care is Cost-Effective," Mayo Clinic, (September 14, 2011), http://www.mayoclinic.org/news2011-sct/6445.html.

[43] "Madison Telephone Partners with Hospital to Improve Rural Healthcare," *TeleState*, Volume 18, No.1, Spring 2009, http://www.il-ita.com/publications/spring_2009.html. Also see Prante, Linda, "Madison Telephone Forges Lasting Community Partnerships," *Exchange*, NTCA, (April/May 2010).

[44] *Ibid*. 15. Also see Letter from Larry E. Sevier, CEO General Manager of Nex-Tech, to the Honorable Jerry Moran, U.S. Senate, Re: Universal Service Fund Reform and Rural Health Care, February 28, 2012.

including teleradiology and teleconsultations between different health care providers, patients and specialists, while also facilitating continuing education for practitioners.[45]

At Smith County Memorial Hospital (Smith Center, Kan.), patients use broadband to consult with medical specialists at larger institutions such as Hays Medical Center (Hays, Kan.), and Good Samaritan Hospital (Kearney, Neb). At Russell Family Medical Care (Russell, Kan.), physicians access digital images via the patient's EHR. This allows the physician to remotely analyze and monitor a patient's progress. Two local health care facilities, Sheridan County Health Complex (Hoxie, Kan.) and Russell Regional Hospital (Russell, Kan.), reiterate that telemedicine and HIT require high-speed broadband. Both facilities are interconnected with local clinics and regional hospitals through a 10 Mbps symmetrical broadband pipe provided by Nex-Tech.

In the future, these western Kansas health care facilities plan to increase their use of broadband connectivity.[46] A number of rural health care facilities already are utilizing data centers to store their information rather than relying on in-house servers with higher maintenance costs. Phillips County Hospital (Phillipsburg, Kan.), is investigating a system that will provide automatic back up of its files every 15–20 minutes. It also plans to explore a real-time application that will provide around-the-clock connection to a pharmacist. Hays Medical Center and Graham County Hospital (Hill City, Kan.) desire to extend telemedicine to in-home use so that patients can avoid the sometimes difficult and long trip to the hospital facility.

The U.S. Department of Veterans Affairs pioneered the use of remote home health monitoring devices, which collect and store biometric health information from patients and transmit the data to health care practitioners.[47] The technology enables health care providers to accurately monitor and intervene in the patient's care before he presents at the doctor's office or hospital. In 2002, the U.S. Veterans Association found that in-home chronic disease management tools (e.g., teleconsultations, remote diabetes monitoring) resulted in a 40% reduction in emergency room visits, 63% reduction in hospital admissions, 60% reduction in hospital bed days of care, 64% reduction in nursing home admissions and 88% reduction in nursing home bed days of care.[48]

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[45] *Ibid*.

[46] *Ibid*.

[47] U.S. Department of Veterans Affairs, VHA Office of Telehealth Services, Care Coordination/Home Telehealth, http://www.telehealth.va.gov/ccht/index.asp.

[48] Marlis Meyer, Rita Kobb, and Patricia Ryan, "Virtually Healthy: Chronic Disease Management in the Home," *Disease Management*, July 5, 2004, Volume 5, Issue 2, p. 87-94, http://online.liebertpub.com/doi/abs/10.1089/109350702320229186.

Remote patient monitoring has widespread applicability, from those who suffer from chronic illnesses to monitoring infants and the elderly. Currently, most doctors cannot receive reimbursement from insurance companies for remote care devices, but pressures on the U.S. health care system are effectively mandating that practitioners do more with less. According to a May 2011 report by health care market research firm Kalorama Information, remote patient monitoring technologies will play a major role in U.S. health care. Kalorama projects the market to grow 26% overall, from $6 billion in 2011 to more than $18 billion by 2014.[49] A more recent and conservative report by Technavio estimates that the global patient monitoring market will reach $9.3 billion by 2014.[50] Regardless of the exact figure, the nascent remote patient monitoring market is poised for exponential growth.

As we look toward the future, broadband technology can help to address the many challenges faced by health care administrators, providers and patients. It also can help to bridge the gap between health care availability and patient need. The smart rural community should strive to implement a dynamic health care infrastructure that facilitates telehealth and other emerging smart health initiatives.

Agriculture

Contrary to popular misconception, agriculture is a technology-intensive industry. Technological advances over the past several decades have allowed farmers to reduce costs, increase efficiency and productivity, and tap into markets that were previously unattainable. The smart rural community will enable farmers to continue to reap gains from broadband technology.

Broadband allows farmers and ranchers to monitor market conditions, and makes it dramatically easier for farmers to collect price information for both inputs and outputs, thereby maximizing the profits derived from their products. By dealing directly with potential buyers, farmers can avoid the costs of engaging third-party agents. In addition, broadband opens up new markets that were previously unreachable. Farmers and ranchers cannot only identify and connect with potential customers worldwide, but they can use broadband to address logistical matters such as gaining necessary permits and other paperwork to facilitate trade.

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[49] Jackson, Sara, "Mobile Health App Market Predicted to Hit $400M by 2016," *FierceMobileHealthcare* (November 28, 2011), http://www.fiercemobilehealthcare.com/story/mobile-health-app-market-predicted-hit-400m-2016/2011-11-28.

[50] Bowman, Dan, "Global Patient Monitoring Market to Hit $9.3B by 2014," *FierceMobileHealthcare* (May 17, 2011), http://www.fiercemobilehealthcare.com/story/global-patient-monitoring-market-hit-93b-2014/2011-05-17.

With broadband connectivity, farmers can instantly access accurate, up-to-the-minute weather information and plan accordingly. They can download software updates for automated farm equipment. Should their equipment break down, farmers can send a photo of the broken part to an equipment dealer anywhere in the world, minimizing both repair cost and downtime. Likewise, if a farm is facing infestation from a particularly noxious pest, the farmer can send a photo of the pest to experts who can speedily advise as to the best method of dealing with the threat, minimizing any potential crop damage. These broadband-enabled applications are especially useful in rural areas, where technicians or other experts might otherwise be required to travel great distances for an on-site visit.

Broadband also enables precision farming, which is a management technique that relies upon geospatial tools, satellite imagery and information technology. Precision agriculture provides farmers with information to improve decision-making throughout the crop lifecycle. Using a Global Positioning System (GPS) system, the farmer can monitor and track his land in ways that were previously impossible.

The farmer can create detailed maps of his land, including seed varieties, wind speed, chemicals applied and crop yields. Using these maps and GPS connectivity, the farmer is able to locate his precise location in a field. GPS-enabled farm equipment is more precise, thereby reducing the use of inputs (water, fertilization, pesticides, etc.), the resultant costs and the environmental impacts, and improving crop yields. A 2004 Purdue University Study on a 1,800-acre farm found that a farmer will decrease his hours of operations by 17% if he uses high accuracy GPS. This results in a decrease in fuel consumption, maintenance, labor hours, and inputs such as seeds, pesticides and fertilizer.[51]

International suppliers such as John Deere, Caterpillar and Trimble offer a variety of precision agriculture products. The next-generation of precision agriculture combines existing geospatial capabilities with broadband connectivity, enabling information to be seamlessly transferred between the office and the field. In 2011, John Deere introduced FarmSight, which unites geospatial precision farming tools with broadband for wireless data transfer.[52] Caterpillar offers Product Link[53] for remote fleet management, and its

[51] Watson, Matt and Jess Lowenberg-DeBoer, "Auto-Steer Opportunities for Crop Management," Purdue University, Proceedings of Indiana Crop Adviser Conference 2004, http://www.agry.purdue.edu/CCA/2004/PDF/Lowenberg.pdf.

[52] "John Deere Introduces FarmSight, John Deere, http://www.youtube.com/watch?feature=player_embedded&v=mNBa0MlkdXI. *Also see* John Deere FarmSight, http://www.deere.com/wps/dcom/en_US/campaigns/ag_turf/farmsight/farmsight.page.

[53] Product Link, Caterpillar, http://www.cat.com/itpaystoknow.

interface called Cat Vision Link,[54] a Web-based application hosted by Trimble. Using these applications, farmers gain insight into the operation, health and productivity of their fleet, including working and idle hours, fuel consumption, start and stop times, and event and diagnostic info in case of machine failure. Vision Link also connects with Caterpillar's PartStore for online parts ordering.

The Connected Farm by Trimble[55] transfers real-time data between the office, vehicles and handheld devices. Users are able to share field maps, equipment guidance lines and other points of interest. Famers can collect survey data, soil sample locations and yield information and send it back to the office for detailed review and processing. Users also are able to remotely track equipment and receive text alerts if employees enter restricted farm zones. All of this information is synched to the user's computer and available through an online portal, MyConnectedFarm.com.

Wireless broadband-enabled sensors are used in many aspects of farming and ranching. Headquartered in Lilburn, Ga., a new company called iLinc Technologies LLC provides real-time, Web-based remote monitoring, management and control solutions for a variety of industries, including the agriculture market.[56] Its FarmLinc system includes remote soil sensors that transmit real-time data such as soil moisture, temperature and rain gauge measurements.[57] The information is transferred to an Internet application. The data can be accessed in several formats, or alerts can be sent via email or text message for any configured abnormal sensor data conditions.

Using wireless sensors, farmers and ranchers can track the location of inventory, from farm to dinner table, and monitor the health of animals. Based in Boulder, Colo., Phase IV Engineering has been engaged in the research development and production of wireless sensing and monitoring products for more than 18 years.[58] The company has created the Phase IV Dairy Cow Monitoring System, which is optimized for livestock management.[59] A wireless sensor can be implanted permanently inside a cow. The system automatically monitors the cow's core temperature and ID as it enters the milking parlor, two to three times per day, and transfers the data via Ethernet or Wi-Fi to an online application. The system allows for the detection of sickness and the onset of calving, before any visual signs

[54] Cat Vision Link, Empire Caterpillar, http://www.empire-cat.com/cm/new_and_used_equipment/new_equipment/technology/visionlink/visionlink.aspx.

[55] Connected Farm, Trimble Navigation Limited, http://www.connectedfarm.com.

[56] iLinc Technologies, http://www.ilinctech.com.

[57] FarmLinc, iLinc Technologies, http://www.ilinctech.com/Products/FarmLinc/tabid/85/Default.aspx.

[58] Phase IV Engineering Inc., http://www.phaseivengr.com/p4main/.

[59] Animal Health: Automatic ID and Cow Temperature Monitoring, Phase IV Engineering, http://www.phaseivengr.com/p4main/Solutions/WirelessSensingSolutionsInDepth/AnimalHealthandIdentification.aspx

appear. This permits early intervention in the health management of livestock, reducing treatment costs and mortality rates.

In Aryshire, Iowa, Randy Loomis uses broadband connectivity on a daily basis in order to support his local corn and soybean farming business.[60] Loomis goes online to check real-time market and commodity prices. The information he gains from the Internet helps him determine where and when to sell his products, choosing between more than 10 different purchasing agents such as an Ethanol plant, and pig and cattle feeders. Likewise, real-time weather reports provide important information about temperatures, wind patterns and precipitation levels, which dictate the best times to distribute herbicides and pesticides and perform other farm operations. As farming equipment, parts and supplies are quite expensive, Loomis uses the Internet to source and purchase the lowest-cost inputs, often participating in remote auctions via real-time online video. Loomis receives broadband service from the local communications provider, Ayrshire Farmers Mutual Telephone, which was established more than 100 years ago in Ayrshire, Iowa. The company serves more than 200 customers with Internet connectivity.

Across the country in south Texas, Swanberg Farms produces cotton and grain sorghum on approximately 9,500 acres in Lyford, Texas. Derrick Swanberg of Swanberg Farms also said that the Internet is an invaluable tool for checking real-time commodity prices, investigating weather conditions and sourcing low-cost supplies.[61] Further, his company purchases a variety of research reports online. For example, a recent online report provided important insight into the volatile prices of fuel. Swanberg Farms owns a 7,700-gallon diesel fuel tank. During the peak season, the farm can utilize its entire diesel supply within 10 days. Accordingly, the farm has a significant interest in tracking current prices so that it can execute less expensive purchases of this input.

Derrick Swanberg also emphasized that his ability to access county and state government offices online enables him to renew his vehicle licenses, contact his local tax bureau and perform other remote transactions, thus saving both on travel costs and time. Based in Raymondville, Texas, Valley Telephone Cooperative provides Swanberg Farms' two offices and remote outbuildings with a 10 Mbps fiber optic connection. The local communications cooperative serves more than 5,200 customers with voice, video and data services. More than 45% of customers receive FTTH broadband connectivity, which enables cutting-edge applications.

[60] Interview with Randy Loomis, March 28, 2012.

[61] Interview with Derrick Swanberg, March 29, 2012.

Absent the availability of reliable broadband service, however, none of these benefits would be attainable. The smart rural community should allow farmers to benefit from the myriad advantages broadband can offer, leading ultimately to increased efficiencies and lower costs.

Electronic Government

The smart rural community should strive to use broadband technology to more effectively and efficiently connect stakeholders with federal, state and local government resources. Use of the Internet can improve the accessibility of public services. Broadband can be employed to distribute information such as regulations, public hearing schedules, agency forms and issue briefs.

The Web also facilitates two-way communication between a government agency and its citizens, a business or another agency. Users can conduct transactions such as submitting a permit application, or applying for services or grants. The Web enables collaboration between other government agencies or branches, businesses and consumers. In a smart rural community, e-government can unite stakeholders who are interested in the economic health and prosperity of the community.

E-government can make agencies more transparent and accountable to their citizens. By breaking down the traditional "red tape" and communications barriers, the Web can empower citizens to become active participants in the governance process.

To promote the government's use of the Internet and other information technologies, Congress authored the E-Government Act of 2002.[62] The act created an Office of E-Government and Information Technology, headed by the federal government's chief information officer, within the Office of Management and Budget.[63] It also established the E-Gov Fund to support long-term projects, and a measurement system by which each agency can determine if its e-government initiatives result in clear progress toward agency objectives, strategic goals and statutory mandates.

In 2009, President Barack Obama furthered this initiative, committing his administration to an unprecedented level of openness. The Open Government Directive seeks to "ensure the

[62] For more information on the E-Government Act of 2002, see H.R.2458, http://thomas.loc.gov/cgi-bin/bdquery/z?d107:HR02458:|TOM:/bss/d107query.html.

[63] For more information, see the Office of E-Government & Information Technology website at http://www.whitehouse.gov/omb/e-gov.

public trust and establish a system of transparency, public participation, and collaboration" by requiring agencies to reveal their operations and disclose relevant public data.[64]

With this high-level commitment to information technology, federal, state and local government agencies have modernized their communications and processes. Perhaps the most well known example of broadband facilitating government services is the Internal Revenue Service's (IRS) Free File program. The program enables eligible taxpayers to prepare and electronically file their tax returns over the Internet using commercial software. The free filing service can be accessed at IRS.gov, and is made possible through a partnership between the government and the Free File Alliance, a consortium of tax preparation software manufacturers. Since its inception in 2003, IRS Free File has generated more than 33 million returns.[65]

Small businesses are the lifeblood of rural communities; it is vital that they have access to government services. The Small Business Administration funds and operates the Business Gateway Program Office, which provides innovative information services to the small business community through a collaborative partnership with federal, state and local government agencies.[66] Originally launched in 2004 as a partnership among 22 federal government agencies, Business Gateway assists small businesses as they launch and manage their operations.[67]

The Business Resource Portal, business.usa.gov, provides a single cross-agency information and collaboration point. The prime advantage is that small business owners no longer need to visit multiple websites to find government resources, funding programs, forms, contacts, and guidance with respect to laws and regulations. Business.usa.gov includes a search engine that queries information from more than 10,000 federal, state and local government websites.[68] Business.usa.gov also employs online tools to engage small business owners, support organizations, industry experts and agency partners. The website connects users through discussion forums, social networks and microblogging.

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64 Obama, Barack, Memorandum for the Heads of Executive Departments and Agencies, Subject: Transparency and Open Government, http://www.whitehouse.gov/the_press_office/TransparencyandOpenGovernment.

65 Report to Congress on the Benefits of the President's E-Government Initiatives, Fiscal Year 2012, Executive Office of the President of the United States, p.13, http://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/fy12_e-gov_benefits_report.pdf.

66 Report to Congress on the Benefits of the President's E-Government Initiatives, Fiscal Year 2010, Executive Office of the President of the United States, p. 8, http://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/FY10_E-Gov_Benefits_Report.pdf.

67 *Ibid*.

68 *Ibid*.

Like their federal counterparts, state and local government agencies are availing themselves of Internet technology. In 2011, Montana moved an important registration process online. The state requires that branding information for livestock be recorded, or renewed, at least once every 10 years. Brands are required for livestock to help prevent loss or theft, and also provide an easy method to return livestock that are separated from their owners. In 2011, for the first time, the registration process was made available online.[69] Livestock owners were able to submit their information at Rerecord.mt.gov, rather than being required to submit the paperwork via the mail or in person to the office in Helena, Mont. More than 60% of registrants took advantage of the convenience offered through the website.[70]

In addition to an outdated submission process, the branding records were stored in an obsolete disk repository that housed more than 55,000 active entries in a hard-to-access format.[71] As of 2010, brands are housed in an online database that can be queried easily, and the state is working to make it publicly accessible.[72] Montana also plans to expand the service to include email notifications and the capability for livestock owners to update their addresses and other information online.

The U.S. Department of Agriculture recently announced technology enhancements for the Farm Service Agency (FSA) as part of the agency's plans for modernizing and accelerating services delivery, and improving the customer experience through the use of technology.[73] The FSA has optimized its website for mobile Web access. FSA also offers AskFSA and AskFSAmobile, a knowledge database with answers to frequently asked questions. In addition, FSA now offers farmers and ranchers more efficient and timely options for receiving program information, such as eligibility requirements and deadlines, through an electronic news service hosted by GovDelivery. By signing up for free online communications, farmers and ranchers can have news sent directly to their offices or mobile devices.

The government has committed to a long-term communications strategy to place its information online and communicate with its constituents via broadband. The smart rural

[69] Rich, Sara, "Montana Livestock Re-branding Mooved Online," *Government Technology*, (January 26, 2012), http://www.govtech.com/e-government/Montana-Livestock-Branding-Mooves-Online.html.

[70] *Ibid*.

[71] *Ibid*.

[72] *Ibid*.

[73] "USDA Offers Mobile Access and More Efficient Online Tools for Farmers and Ranchers," U.S. Department of Agriculture, Rural Development (February 10, 2012), News Release No. 0047.12, http://www.usda.gov/wps/portal/usda/usdahome?contentid=2012/02/0047.xml&contentidonly=true.

community will provide the broadband infrastructure necessary to connect its businesses and citizens with government resources.

Public Safety

The smart rural community should have the capability to operate a cutting-edge, public safety wireless broadband network that is reliable and interoperable with other local, regional and national first responders. A next-generation network enables emergency management personnel to send and receive critical voice, video and data information. In the case of a regional or national disaster, all emergency management personnel can communicate and stay apprised of the latest developments.

A next-generation network allows public safety managers to track, in real-time, police, fire and ambulance resources. While on-site or traveling to or from an incident, medical responders can access patient EHRs. Medical personnel also are able to transmit real-time biometric readings from the patient and send high-quality video of the patient's status to the medical facility in advance of their arrival. When responding to a safety threat, police have real-time access to criminal databases and on-site video surveillance feeds via their handheld wireless devices.

The smart rural community also should investigate a next-generation 911 (NG911) alerting system. NG911 enables the public to transmit text, images, video and data to public safety answering point (PSAP) from broadband-capable devices and applications. Likewise, NG911 notifies Americans about emergencies and disasters via a variety of mechanisms, such as local TV and radio broadcast alerts, messages sent to wireless phones within the affected area(s), notices posted on Internet feeds and websites, and in various languages and formats as well.

With NG911, emergency personnel can foresee and respond to a variety of issues through real-time monitoring of traffic, accidents and environmental conditions. For instance, under the current system, in the event of a major highway accident or a hazardous material spill, the PSAP may receive many calls from different motorists. This can cause the center to become overloaded, leading to confusion about the exact location, which can delay emergency response times. In the NG911 environment, broadband-enabled vehicles automatically send important crash data to the PSAP so it can dispatch first responders. Broadband-enabled highway message signs are directed to display the warning, and everyone in the vicinity with an Internet-connected device can be notified to avoid the area.

A nationwide public safety network has yet to be built, and standards have not been set for its accompanying devices and applications; however, emergency management personnel are taking incremental steps to evolve their current systems. In August 2009, a PSAP in Black Hawk County, Iowa, became the first call center in the nation to accept text messages sent to 911.[74]

This technology is a vast improvement for hearing- and speech-impaired citizens who previously would have needed to contact 911 through a fixed home-based interpreting center such as a TTY or TDD device.[75] With NG911, the disabled individual can contact the PSAP from any mobile device and carry on an instant message conversation or a text thread, with accompanying video and pictures when necessary.

In July 2011, Durham, N.C., launched the city's NG911 network, which provides the Durham Emergency Communications Center with advanced voice capabilities and the building blocks to support text messaging, cell phone pictures, video clips and other data services.[76] The city also is conducting a similar trial for text-to-911 services.[77]

Also in 2011, two Georgia municipalities were among the early adopters of a Smart911 service, which officials say will improve emergency response.[78] Through an online Smart911service, citizens can create online profiles that provide personal information such as phone numbers, household information, medical conditions, photos of children and information about their pets. If a 911 caller has a Smart911 profile, then the emergency operator forwards the relevant profile information to the first responders, who will be better equipped to meet the caller's unique needs. The information is secured on the company's servers, so the city has no access to profile information until a user calls 911. The service is free to consumers, but the municipality pays a fee per user. Smart911

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[74] Svensson, Peter, "Iowa 911 Call Center Becomes First to Accept Texts," August 5, 2009, Associated Press, http://www.usatoday.com/tech/news/2009-08-05-text-911_N.htm. Also see "9-1-1 Text Messaging Helps Save Lives in Black Hawk County," Intrado, http://www.intrado.com/resource/nextgen911/media/Black%20Hawk%20County%20Case%20Study.pdf.

[75] A TDD is telecommunication device for the deaf. However, TTY, a text telephone, is the more widely accepted term, as TTYs are used by many people, not just those who are deaf. A TTY is a device that lets people who are deaf, hard of hearing or speech-impaired use the telephone to communicate by allowing them to type messages back and forth to one another. A TTY is required at both ends of the conversation in order to communicate.

[76] "Intrado & City of Durham Launch First NG9-1-1 Network in NC," *9-1-1Magazine.com,* (September 26, 2011), http://www.9-1-1magazine.com/Corp-News-Intrado-Durham-NG911-System

[77] "Durham 9-1-1 Center Extends Texting Trial for Emergency Help," *9-1-1Magazine.com*, (January 30, 2012) http://www.9-1-1magazine.com/PPT-Durham-Text-to-911-Trial-Extended.

[78] Rich, Sara, "911 Responders in Georgia Aided by Online Citizen Profiles," *Government Technology* (March 7, 2011), http://www.govtech.com/public-safety/911-Responders-in-Georgia-Aided-by-Online-Citizen-Profiles.html.

sends notifications twice a year asking its users to update or validate their online information.

In Chattanooga, Tenn., the local utility provider electric power board (EPB) has deployed the first 1 Gbps fiber-to-the-home (FTTH) network throughout its 600 square mile service territory, thereby making it the fastest broadband network in the nation. EPB also has deployed a mesh WiFi network in its city areas. The broadband provider uses the wireless network for a variety of public safety applications.

Each patrol car is outfitted with high-speed mobile Internet access, allowing maps and crime scene information to be transferred between headquarters and officers in the field.[79] Patrol cars also can receive live video streaming from other squad cars and security cameras places around the city.[80] In known areas of criminal activity, police have installed security cameras that alert officers when suspicious activity is detected. The officer can monitor the live video feed from his patrol car, or remotely turn on lights in the area.

The Chattanooga police department also has invested in a 3-D scanning system, which is the latest technology for crime scene investigation.[81] The wireless laser can scan an area the size of a football stadium and use billions of points of data and details down to a quarter of an inch to create a 3-D-model of a crime scene. Instead of sending a team of detectives to secure and document the scene, the model can be transmitted to headquarters. This process, which can reduce the number of personnel needed on-scene, can transform an otherwise time- and labor-intensive process into digitization that takes only minutes.

As the nation looks to develop a ubiquitous, next-generation public safety broadband network, the network can facilitate a variety of new applications. The smart rural community should ensure that it has the capability to connect to this new network. The smart rural community also should strive to implement the underlying infrastructure required for a NG911 alerting system.

Utilities

The smart rural community should strive to modernize utility networks—such as energy, transportation, water and waste—with intelligent, broadband-enabled infrastructure.

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[79] Berg, Nate, "Gigabit Cops," *The Atlantic*, (November 22, 2011), http://www.theatlanticcities.com/technology/2011/11/gigabit-cops/546/.

[80] *Ibid*.

[81] *Ibid*. Also see Hardesty, Linda, "Chattanooga Rocks When it Comes to Broadband," *Communications Technology* (August 29, 2011), http://www.cable360.net/ct/news/ctreports/commentary/47901.html.

In rural areas, one of the most common implementations is the smart energy grid, which incorporates communications and information technology into the generation, transmission, distribution and consumption of power. The smart grid utilizes broadband and IP connectivity to create a more efficient, reliable, resilient and responsive network. It aspires to intelligently detect and resolve problems within the electrical system. Smart infrastructure will provide the electric provider with far greater insight into the grid, and the consumer with more information and control over his energy usage and expenditures. As a result, it promises to lessen environmental impacts by reducing overall peak demand for power, successfully integrating renewable energy into the network and supporting the widespread adoption of electric vehicles.

The smart energy grid will not be implemented all at once, but rather in an evolutionary manner. The downstream deployment of a smart meter at the customer's premises connected to a central network is often referred to as advanced metering infrastructure (AMI). Technology that connects and improves the energy distribution system, including the utility's sensors, switches, voltage controls and its monitoring system control and data acquisition (SCADA) systems at substations can be implemented independent of other updates. Another phase will involve the remote storage of energy in a decentralized fashion.

A variety of other infrastructure providers—such as water treatment and distribution plants, wastewater collection and treatment operators, oil and gas pipelines, and transportation operators—also are installing SCADA systems in order to obtain more insight into their operations and control over their networks. A network-enabled SCADA system provides remote monitoring and control of all areas from a centralized location. In addition to communications infrastructure, it typically includes connected field devices such as remote terminal units, sensors and programmable logic controllers. SCADA systems enable equipment and software to be updated and accessed from any network-enabled location. They can be part of a private network, or connected to the public Internet.

A SCADA system reduces or eliminates the need for employees to patrol the perimeter of the operations or visit remote sites. At the same time, it promises to immediately identify security issues and abnormal operating conditions. The system also can be designed to automatically react to certain conditions, such as providing an early warning in the case of a contaminated water treatment plant, or even isolating parts of a plant if a foreign entity is detected.

It is important to note that because SCADA systems can provide for the automatic and remote control of a utility system, cybersecurity is an important consideration. These

systems are vulnerable to virtual attacks that may disrupt the operations of the utility provider and damage equipment. The primary security vulnerabilities for SCADA systems are the communication links, the computer software and power sources for the various components.

In order to facilitate broadband-enabled operations, utility providers will need broadband infrastructure to connect remote locations and central offices, and, in the case of distribution networks, the customer's premises. The network can use wired, wireless, cellular or mesh topology.

According to the Environmental Protection Agency (EPA), more than 94% of the nation's 156,000 public water systems serve fewer than 3,300 people.[82] The agency reports that small public water systems, where the source of the water is a significant distance from the drinking supply, are more likely to be threatened by bacterial growth, corrosion and direct contamination from chemical, biological or radiological substances.[83] However, small water systems have not traditionally installed SCADA systems because of costly service agreements and complex operating systems that required specially trained computer programmers or technicians.[84] The EPA reports that in the last few years, the design and fabrication of SCADA systems have changed, making them more practical for small drinking water treatment operators.[85]

In November 2011, the U.S. Department of Agriculture (USDA) announced that the town of Somerset, Kan., had broken ground on a new project at the city's water treatment plant.[86] Through the USDA's Water and Environmental Programs, the city was able to obtain a low-interest loan in the amount of $14 million and a grant for $6 million. Funding was provided as part of the American Recovery and Reinvestment Act of 2009. The improvements will benefit approximately 5,643 people within the city limits, in addition to customers who reside in neighboring towns, which also are served by the plant. The funds will be used to increase the capacity of the existing plant from 10 million to 16 million gallons per day, and

[82] Basic Information, Water: Small Systems and Capacity Development, U.S. Environmental Protection Agency, http://water.epa.gov/type/drink/pws/smallsystems/basicinformation.cfm.

[83] Small Systems Security, Small Systems Research, U.S. Environmental Protection Agency, http://www.epa.gov/nrmrl/wswrd/dw/smallsystems/sssecurity.html.

[84] *Ibid*.

[85] *Ibid*.

[86] Somerset-Pulaski County to Break Ground on New Water Treatment Plant," U.S. Department of Agriculture, Rural Development, (November 15, 2011), New Release No. STELPRD4013786, http://rurdev.usda.gov/STELPRD4013786_print.html.

other improvements and upgrades to the plant, including the deployment of a remote monitoring solution from General Electric Water & Process Technologies.[87]

Based in Ellendale, N.D., Dickey Rural Networks understands the importance of remote monitoring solutions for water utilities. The communications provider recently approached its local water provider with a proposal to install a private broadband network.[88] The technology will be used to monitor and control 12 remote lift stations and reservoir sites, providing the utility with greater intelligence and insight into its operations. Dickey Rural Networks has submitted a plan to manage the broadband infrastructure throughout the utility's footprint. The company has more than 62 years of history developing telecommunications networks, and the plan is intended to leverage Dickey Rural Network's existing investment and deployment of 100% fiber-based infrastructure.

In addition, Dickey Rural Networks is involved in the large implementation of a smart grid electric project with two of its local electric providers: Dakota Valley Electric Cooperative, based in Milnor, N.D., and Northern Plains Electric Cooperative based in Carrington, N.D. In rural areas, often the footprint of the local electric provider is much larger than the territories of the local broadband providers. As such, Dickey Rural Networks has collaborated with its state network and several neighboring telecommunications companies to install a fiber-based virtual private network (VPN) throughout the electric transmission network. This private broadband network will be used to monitor and control remote sites in the electric grid. The broadband network also will be used to facilitate communications between electric company employees at each of these stations. Dickey Rural Networks already has turned up the first three of 76 substations that will be part of the private network; as additional infrastructure is deployed throughout the summer of 2012, the smart grid network will be brought online.

In rural Idaho, another rural telecommunications provider is working collaboratively with its neighboring electric companies to incorporate broadband-enabled architecture into the electrical grid. Based in Albion, Idaho, Albion Telephone Co. began investigating smart grid services back in 2007, as part of the company's efforts to diversify its services and capabilities. In November 2008, the broadband provider instituted a smart meter infrastructure project with Raft River Electric Cooperative Inc. in places where the service territories overlap.[89] Based in Malta, Idaho, Raft River Electric deployed smart meters at

[87] Knowledge Central, GE Power & Water, Water & Process Technologies, https://knowledgecentral.gewater.com/kcpguest/loginPortal.do. Also see "Insight: Remote Monitoring Performance – A Discussion in Question and Answer Format," GE Water Process Technologies, http://www.gewater.com/pdf/Capability%20Profiles%20FAQ_Cust/Americas/English/faq1005en.pdf.

[88] Interview with Jeff Wilson, general manager, Dickey Rural Networks, March 26, 2012.

[89] Interview with Robert Peterson, special projects manager, Albion Telephone Co., April 2, 2012.

customer homes. Usage data, in analog format, is collected every five minutes and transferred over powerlines to Raft River Electric's substations. The data is then converted to Ethernet traffic and transported over Albion's fiber network to Raft River Electric's central office. Albion Telephone also is investigating another collaborative partnership with a separate local electric provider, Lost River Electric Cooperative Inc. headquartered in Mackay, Idaho. This new project plans to use Albion's wireless facilities and wired network, both cooper and fiber, to backhaul traffic from the smart meter at the customer's premises to the electric provider's central office and achieve 100% coverage required by the electric cooperative.

Another cooperative, NineStar Connect (Greenfield, Ind.), formerly Hancock Telecom, decided to enter the smart grid market with a different approach. In 2011 Hancock Telecom merged its operations with an electric cooperative, Central Indiana Power (CIP), also based in Greenfield.[90] In 2010, the two companies, which have 4,000 customers in common, examined the cost benefit of shared resources. For example, CIP utilized Hancock Telecom's 24-hour call center for after-hours customer support. Today, NineStar Connect plans to become a national leader in smart grid applications. The company plans to deploy smart meters to all of its electric subscribers, although it has started this process with the 4,000 common customers, many of whom currently have FTTH broadband service.[91] To reach the other approximate 7,000 electric customers, NineStar Connect plans to build out its fiber infrastructure as a competitive provider.[92]

In the quest to build smart utility networks, rural utility and broadband providers can partner to leverage each other's strengths and share resources. Rural communications providers are equipped with the network capacity and technical expertise needed to build out the network. There is no one-size-fits-all approach; this partnership will be different in every community. However, the smart rural community will collaborate with its local utility providers to evaluate new broadband-enabled services and remote monitoring solutions.

The Consumer's Home

The smart home enables energy efficiency and appliance automation. The smart home network may include appliances, smoke alarms, security systems, entertainment gadgets,

[90] Shields, Tennille, "Hancock Telecom Makes History With Merger," *The Exchange*, NTCA (December 2010/January 2011).

[91] Information obtained from David Spencer, director of marketing, NineStar Connect, April 3, 2012.

[92] *Ibid*.

medical devices, thermostats and any other electronic device that has IP connectivity. It is predicted that the smart home of the future will contain devices that are able to communicate with each other and be controlled through one central device, and/or remotely via an Internet application. Most current applications relate to lighting, home security, home theater and entertainment, and thermostat regulation.

Real-time energy pricing, analysis and decision-making are critical elements of the smart home. The smart meter, which will reside at the customer's home or business, will measure historical and real-time energy consumption. The smart meter can be used in conjunction with a gateway and a home area network. If appliances are connected to the local network, the consumer will be able to program them on a schedule via one convenient tool. Consumers also will be able to make on-the-spot decisions based upon current energy conditions and the resultant prices. With a networked smart meter, the consumer will understand, in real time, the relative costs of setting a thermostat at 75 compared to 78 degrees, or to dry clothes and charge an electric car during peak-load versus low-demand times.

The possibilities are endless. If the customer activates an oven to cook a meal when electricity prices are high, the stove might tell the refrigerator to delay defrosting or adjust its temperature until dinner is served. Likewise, the washing machine will be able to communicate with the dishwasher, ensuring that it will switch on only after the clothes are cleaned. Through the use of a home network and Web applications, the end user might also be able to create operation protocols, or "rules," for appliances, such as specifying a monthly electricity budget and instructing his appliances to operate within that defined budget.

The smart home concept will take this one step further, automating a variety of appliances. Imagine a typical workday in the not-too-distant future: a cellphone alarm rings; 30 minutes earlier it communicated with the thermostat, requesting a preferred "wake-up" temperature. Ten minutes prior it started the coffeemaker, and it now turns the TV to a favored news channel.

Alternatively, the alarm rang 20 minutes earlier than expected: that is because it retrieved weather and traffic information and calculated the impact of those conditions on the daily commute; it also communicated with the car to ensure that the electric engine re-charged itself overnight, as planned.

The car de-ices the windows and contacts a GPS device in order to obtain the most updated directions based on road closures and information. As the user drives away, the car signals

the home automation system to lock all doors, change the thermostat to save energy and arm the security system.

Although this vision might sound like the stuff of futuristic science fiction movies, it is within reach. Rural telephone and broadband providers are at the forefront of the smart home trend, introducing next-generation security services that can be upgraded in the future to full-fledged automation platforms.

In September 2007, rural communications provider Atlantic Telephone Membership Corp. (ATMC; based in Shallotte, N.C.), launched a state-of-the-art security offering, ATMC Security, that helps protect against intrusion and break-ins, fire, smoke, carbon monoxide, rising water and fluctuating temperatures.[93] ATMC Security communicates via wireless or wireline telephone with a 24-7 monitoring company.

ATMC primarily is a distributor of Honeywell security products, including the vendor's Total Connect Remote Services.[94] The system can be accessed and configured from any Apple iOS, Blackberry or Android smartphone. It also can send real-time alerts via email, text message or video. For example, a text message can be sent when a child arrives home, or an elderly individual leaves the premises. Likewise, with video services, the user can check in on his property and loved ones from any online access point. Further, customized video alerts can be triggered based upon pre-defined criteria such as movement or schedules. This is particularly important for the rural customer who may have an expansive and remote property. Elderly citizens will appreciate the availability of a medical alert monitoring application, wherein the user wears a pendant that can be triggered to call the home monitoring company and his loved ones.

In Conway, S.C., Horry Telephone Cooperative (HTC) offers a similar security service, relying upon Honeywell and DSC vendor products.[95] HTC also recently launched the Total Connect Remote Service from Honeywell, which allows users to interface with the system from their smartphones.[96] The communications provider views its security service as a method to differentiate itself from its national and regional competitors, and entice home owners and developers to adopt a bundled package of services. Looking toward the future, HTC is closely watching the smart grid and automation trends.[97] As the economy recovers, HTC foresees that smart home services may be quite popular and in demand with users. If

[93] Protect Your Family, ATMC Security, http://www.atmc.net/res/security-home.aspx.

[94] For more information about Honeywell Total Connect Remote Services, see http://www.mytotalconnect.com/.

[95] "HTC Security: Protect What You Value Most," HTC, http://www.htcinc.net/integration_security.cfm.

[96] Interview with Brent Groome, customer operations officer, Horry Telephone Cooperative, March 30, 2012.

[97] *Ibid*.

this is the case, HTC is in a great position to build upon the technology it has in place and the customer segment it has developed with its initial foray into home security services.

The smart rural community should investigate new home automation services that offer energy efficiency and cost savings. Additional applications may provide the user with enhanced security, medical monitoring and convenience applications.

Technology Infrastructure

Broadband is the backbone of innovation. New, innovative applications are created when there is a technological platform in place. For example, in 2007 Apple introduced the iPhone, a game-changing smartphone marketed to the general populace, and an open platform for developers to create new applications that take advantage of wireless network connectivity. A few months later, Android emerged with the launch of the Open Handset Alliance. This changed the focus of the wireless marketplace, with other equipment manufacturers quickly following suit to create open platforms that encourage external development. In 2012, there are now more than 1 million apps available for a range of smart mobile devices. Likewise, a robust, future-proof wired broadband network will create opportunities for new applications that benefit individual users, vertical industries and the community as a whole.

A robust broadband network is the foundation of a smart rural community. The network must be capable of supporting sustainable economic activity for the community's citizens. This includes a wide variety of applications that meet the community's current needs. Likewise, the broadband network needs to be future-proof, with a clear, long-term path forward to continually upgrade its infrastructure and capacity.

Today's smart rural community requires a ubiquitous telecommunications network with broadband access capability of at least 20 Mbps to the consumer's premises, and 1 Gbps capability to institutions such as hospitals, libraries and schools. As rural areas looks to remain economically competitive with their urban counterparts, comparable broadband technology will be critical.

Wired infrastructure is the backbone of the network, providing reliable, high-speed connectivity. However, some applications demand mobile access. As such, the smart rural community should offer a 3G wireless network with a defined path to upgrade to 4G technology.

IP multimedia subsystem (IMS) is poised to emerge by 2013 in many mobile markets. The technology has the capability to unite wired and wireline networks for fixed mobile convergence applications. The smart rural community should ensure that its network continues to keep pace with advances such as IMS architecture.

Likewise, the local broadband provider should have an updated cybersecurity plan in place. Network security is critically important. The smart rural community should depend upon broadband infrastructure to unite and coordinate the efforts of a variety of vertical industries, companies and individual users. As end users start to rely upon next-generation applications for critical security, education, health, infrastructure and commerce needs, the network must be capable of sustaining deliberate attacks.

As discussed previously, smart grid technology promises energy efficiency, automation and independence from oil. In order to meet these important goals, the local electric provider should have a defined smart grid action plan and goals.

A Path Forward

It is important to note that the mere presence of a robust, next-generation broadband network does not create a smart rural community. Although each community is different, it is possible that the development of a smart rural community is dependent upon key foundation elements. Identifying these building blocks might assist with the continued evolution and prosperity of small-town America. Collaboration is a key element to creating this innovative atmosphere—as witnessed by those communities profiled herein.

The definition of a smart rural community is dynamic. Each local area must develop its own long-term approach to achieving this goal. Further, the journey to create a smart rural community is an evolutionary process. To remain relevant and competitive, the community—and the network—will need to continue to evolve to meet future needs.

4121 Wilson Boulevard, Suite 1000 • Arlington, VA 22203-1801
Phone/703-351-2000 • Fax/703-351-2001 • www.ntca.org