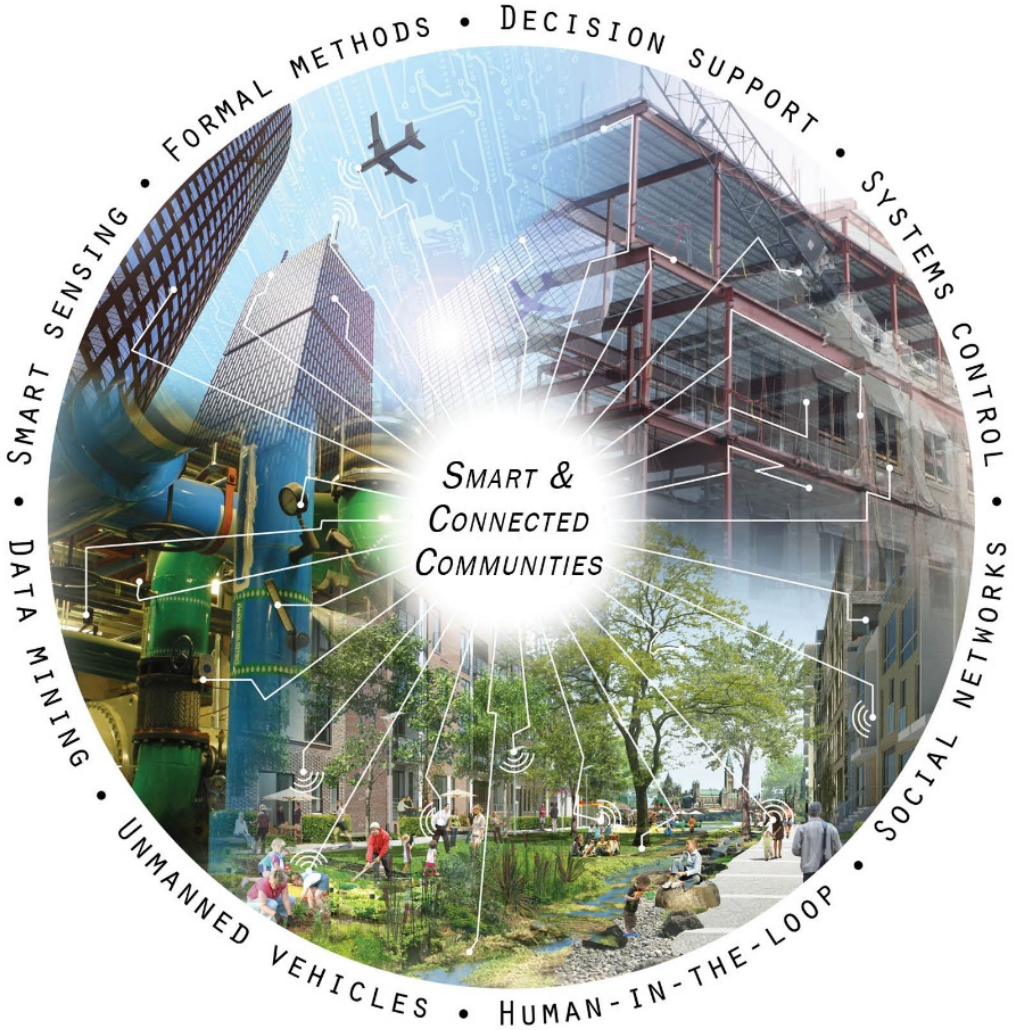
UNIVERSITY of VIRGINIA

WORKSHOP REPORT

National Workshop on Developing a Research Agenda for Connected Rural Communities (CRC17)

September 7 - 8, 2017 • Charlottesville, Virginia USA



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Tho H. Nguyen, PhD

EXECUTIVE SUMMARY

The University of Virginia (UVA) convened a national workshop on September 7-8th, 2017 in Charlottesville, Virginia to examine challenges and opportunities for high-impact technology research to advance quality of life in small, remote, and rural communities. With support from the National Science Foundation (award #1741668), UVA organized a successful meeting of approximately 90 participants representing diverse academic disciplines, industry sectors, government agencies, and community organizations. Participants comprised researchers, practitioners, policy makers, and members of the community. The workshop was organized to include presentations from domain experts as well as engage all participants in detailed discussions to explore practical challenges, share successful approaches, and identify opportunities where new research can make an impact. Over two days, workshop attendees participated in meaningful conversations that exposed new insights and converged on key recommendations for a successful research agenda toward smart and connected rural communities.

Small, remote, and rural communities are an important component of the nation's identity, economy, and global competitiveness; yet, many of these communities are often unable to take full advantage of services and resources offered through communications, networking, and technology advances. These *under-connected communities* can exist within a large urban center or located in remote areas. Due to the varying differences in resources, needs, and interests, no one solution is expected to scale across all communities. Instead, a playbook approach is suggested where cases of successes and failures can be shared, and communities can choose to adopt solutions or best practices that meet their needs.

The lack of infrastructure, especially for communication and networking, is a front and center issue in under-connected rural communities. Researchers are encouraged to pursue practical as well as bold and creative technical approaches to deliver resources and services instead of waiting for advanced infrastructure to be available. Infrastructure development must also couple with capacity building programs to enable communities to take advantage of the newly available services and resources. Quality of service (e.g., accessibility, performance, and cost) must be considered as research drivers and not an afterthought in the deployment phase.

Community culture, values, and identity are the foundation upon which a community can sustain and grow. New socio-technical metrics must be developed to assess the overall community wellbeing and impact of R&D efforts. Capacity building (e.g., orienting a community toward entrepreneurship or developing a new workforce) begins with changing the community's attitude toward changes and adopting new solutions. Community core competencies are important considerations for successful programs. A community-based participatory research (CBPR) model should be considered by technical researchers to engage community input from identification through to the solution deployment stages.

Critical public services in under-connected communities such as emergency response and public safety are challenged by the lack of infrastructure and further burdened by the economies-of-scale bottleneck. For example, advanced data analytics and public outreach are more difficult due to the limited technology, expertise, or simply enough critical mass to justify investment. On the other hand, there are several advantages afforded by rural settings that support service deployment, including low-cost right-of-way, available wireless bandwidth, small-grouped community, and community cohesion. Researchers are encouraged to leverage these

advantages in designing new public service solutions. A key priority identified for public services is to lower the barrier-of-access for community managers and community members. This includes: visualization to support understanding and awareness, automated systems to reduce the need for advanced expertise, and leveraging existing technology services such as social media and crowd-sourcing platforms.

Access to quality healthcare is a critical factor in advancing quality of life in under-connected communities. Currently, availability and quality of healthcare services vary significantly due to limited resources, lack of infrastructure, and policy not responsive to support new programs. Telehealth services are recognized as a successful model for delivering care. Telehealth is also an area ripe for technology collaborations. Assessing community health and health outcomes to measure program effectiveness is also a major hurdle ready for technology innovations. Technical researchers are encouraged to work with social scientists and healthcare providers to identify challenges as well as assessing the impact of intervention programs – including potential unintended consequences (e.g., drone drug delivery). Public health projects are often well-setup for collaborations with other domains such as education, emergency response, and transportation. Data protection is a priority for health intervention efforts. Technology development can also provide more effective methods of collecting, storing, and analyzing health data securely – for example, an end-to-end secured system from wearable and edge devices to a security-compliant cyber infrastructure can engage diverse technology, actors, and enable collaborative research across disciplines.

In addition to addressing the issues summarized above, the following report details many specific technical and social research questions and their dependencies on each other. These questions must be solved to avoid having rural and depressed areas of major cities being left out of the smart city revolution. In spite of many specific research questions being identified, two overarching questions proved difficult for which to articulate specific answers. These questions are: (i) What current smart city technology can or cannot be easily moved to rural communities, and why, and (ii) what totally new technology is required precisely because of the cultural, social, economic and other properties of rural areas?

A few examples of key research challenges are:

- How to enable access to information in the rural community that is easy to use and highly robust?
- How to support using information technology and services even when people or systems become disconnected from the Internet?
- How to create affordable maintenance and use solutions?
- How to make information produced by rural communities an asset?
- How can we take advantage of data science to bring opportunities to communities?
- How do we scale what worked in smart cities into rural environments?
- How do we design and implement better workflow to handle, and disseminate data in acute emergency systems (e.g., active shooter at school) to balance timely access to relevant data and preventing mass hysteria?
- How do we leverage the latest in material technology and integration with the local environment to design sensors and systems that are minimally invasive?

- How can we improve reliability of ad-hoc communication channels (e.g., social media, shortwave radios) for emergency communication and coordination?
- How do we ensure security of these systems and integrate into patient electronic records?

Overall, the community joined in a strong *call to action* for the federal government to create and implement programs and policies specifically targeted at serving the under-connected population. If not done, there is a great risk at leaving rural communities further and further behind the technological revolution and its benefits. Any research agenda on this topic must engage both technologists and community people and organizations. The agenda should include underlying research that spans application domains as well as dealing with specific issues that arise in particular domains such as transportation, education, healthcare, work force development, and emergency and safety services. A research agenda should also leverage current research being conducted on smart cities.

In the following sections, we share detailed notes of discussions as well as specific research questions arising from community consensus. At the end, we also include related and relevant material from government and community organizations further illuminating the challenges and opportunities in advancing quality of life for under-connected communities.

WORKSHOP REPORT

A. The Art of the Impossible: Bridging the Information Gap: Session Chair – J. Stankovic

Subject matter expert speakers:

T. Nandagopal; Rural Broadband: Reality, Challenges, and Opportunities
B. Patterson: Municipal Information Systems
R. Galardo: Rural Economic Development

Breakout session moderators/reporters:

E. Zegura/T. Swartzwelder
S. Das/L. Seuffert
R. Davis/L. Killey
L. Barnes/J. Mokros

Summary:

It is widely recognized that there is a significant information gap experienced by rural communities. However, more details are necessary in identifying where the gaps are. In fact, the definition of a rural community is vague and covers many widely different communities and requirements. For example, one rural community may be agricultural and cover a vast geographic area with a small population. Another rural community may be a small mining town with a main street dealing with very different issues than the agricultural community. Consequently, it is necessary to understand what information is actually necessary for different types of rural communities, what is common, what is different, and what is missing. It is also important that the information provided is actually wanted, affordable, and will be used by the community – we must learn the community needs and values, including its religious practices. Solutions can't be forced on the community. They must account for the culture and mindsets of the people in the community. In other words, it is necessary to empower the rural communities from city managers to individuals so that they "own" the solutions. Change cannot happen overnight so a strategy for implementing broadband and other solutions is necessary.

The information gap experienced by rural communities can be categorized by topic areas, e.g., public safety, education, workforce issues, lifestyle and entertainment, health, and governing. Some of these were covered in other sessions of the workshop. It is important to note that information may be brought to the rural communities via the Internet and other means, it may be collected in the rural community itself, and be both exported and exchanged within the rural community to improve services. It is necessary to enable access to the infrastructure and have contingencies and processes in places if that infrastructure breaks down. An important question that must be resolved by policy and technical solutions is who owns the data.

Generally, access to broadband will improve the information gap. However, cost, maintenance and usability issues must be addressed per application and location – further exacerbating the challenge. In one example, a rural community had broadband access installed and very few people subscribed. This emphasizes the need for value added services to the raw broadband capability and having that added value actually be wanted by the populace. A few other important topics discussed include the following. What role will standards play in the solutions? How will crowd sources and social networking improve the communities? Partnerships

between communities are important and how will information support effective partnerships? This technical problem involves connecting systems of systems, which is often not implemented in a rural community.

Research Questions

Looking holistically at helping rural communities bridge the information gap, research questions seem to fall into several categories – Data and Technology Considerations, Community Considerations, and External Considerations:

1. Data – type, ownership, security, privacy, maintenance, management, and infrastructure
    - How can digitalization of local government data/ records lower costs and allow greater citizen access?
    - How can research innovations be leveraged to support investment models that sustain and grow broadband infrastructure development?
    - How can security and privacy of the information be provided?
    - How can information silos be prevented with different community organizations using different applications?
    - How do we build in cybersecurity awareness and capabilities into the services?
2. Technology - communications, sensing, actuation, computing hardware, software
    - What technology can provide new sources of information, e.g., sensors and wearables in the rural community?
    - What new, creative means can be developed to sense, process, and deliver information on low bandwidth networks?
    - Can TV white space be used? If so, how can we develop better RF propagation and coverage maps for rural areas for planning broadband access?
    - How can we support collaborative efforts of different technology developers?
    - What wireless technologies seem best positioned from an economic standpoint?
    - How can the cost of fiber be brought down so that it is more affordable?
    - Is eliminating or minimizing dead zones with respect to communication possible?
    - How long will the technology last or be viable?
    - How can AI be utilized to create smart rural communities?
    - What technologies and broadband infrastructure are needed for rural manufacturing, especially small lot manufacturing?
3. Access – speed, availability, cost, and performance
    - How do we make access to information easy to use and highly robust?
    - How do we achieve affordable maintenance and use solutions?
    - How can response time in delivering information be reduced, especially for critical services related to emergency response and health?
    - How can the information be used even when people or services become disconnected from the Internet?
    - What applications can be used that are not real-time (i.e., delay-tolerant technologies)?
4. Applications and value added services
    - How can real-time warning systems be created and deployed?
    - Can information and technology further improve smart agriculture?

- How new smart agriculture technology sensors and the data generated can improve farming AND meet regulatory requirements?
- Can information be used for developing effective virtual assistants for education, health, etc.?
- Can telemedicine information be shown to be accurate and safe?
- How can information be collected from homes to detect adherence to medical treatments?

5. Culture
   - How can technology be tuned to the behavior and culture of the rural community?
   - How does the community choose the technology to make the big decisions in investment?
6. Relationships, partnerships and identifying community leadership
   - How do you build the community partnerships?
   - How do the key stakeholders and beneficiaries get identified?
   - How do the project champions get identified and engaged?
   - How do you build trust in the community in order to engage it in the solutions?
   - What non-profits are used to advise the community?
7. Assessing Needs
   - How does the needs assessment get performed for a particular rural community?
   - What is the best way to collect information to understand the community's needs, and how can technology enhance these methods?
8. Identifying and building community assets and resources
   - How do create networks get successfully created among the community members?
9. Building community awareness and training
   - How does one build an awareness in the community about what is possible?
   - How to use technology and information to recruit, retain and train community volunteers?
10. Creating business models to monetize information and applications
    - How to make information produced by rural communities an asset?
    - What are the business models of providing broadband access that empower the end users as opposed to focusing on profits for the operators and corporations?
11. Standards, public policy, and regulations
    - How do technical solutions interact with complex regulatory laws and policies?
12. Discovering applications from other areas (e.g. military, medical)
    - Are there concepts and/or applications from military settings that can be applied in rural settings, either for temporary or permanent access e.g. where the military sets up a temporary communications capabilities in a remote, foreign location.
13. Outside resources – Funding sources, government, corporate and private assets, etc.
    - How can the community get affordable financing for equipment and services?
14. Cross-community coordination
    - How can emerging services for rural communities be coordinated across different rural areas?

B. Social Considerations, Education and Workforce Development: Session Chair – J. Goodall

Subject matter expert speakers:

B. David (Orange Co., VA); Workforce Development
R. Mahaffey (Rural Education & Community Trust): Rural Education
U. Ramachandran (GA Tech): Technology Empowering Community

Breakout session moderators/reporters:

E. Rozier (Iowa State) / C. Qian (Weldon Cooper Center)
M. Hoit (NCSU) / R. Latimer (UVA)
I. Altintas (UCSD) / M. Kennedy (Kennedy Group)
R.S. Sreenivas (UIUC) / J. Cochran (W. VA)

Summary

The research agenda for connected rural communities for Education and Workforce Development should be about the synergy/co-design of two components: (1) heterogeneous supporting-technologies and (2) applications that are apropos to the specifics of the rural-setting. An agenda that concentrates on just one of these, and ignores the need for co-design/synergy, is bound to fail.

For K-12 education, we need a "heat-map" of the relevant metrics (e.g., drop-out rates; student-density, etc.) to develop an understanding of the status quo. Careful thought must go into the selection of these criteria and we will measure success against these, eventually. One of the positives of the "Broadband Panacea" is that there is a lot of material on line that gets to reach the rural communities (e.g., Khan Academy, etc). Improved connectivity has helped the schools in Idaho, where workshop participants shared that there is almost an equal percentage of On-line and Bussed Rural Schools. One of the issues with the "Broadband Panacea" is that we need an effective "app" that deals with hands-on/learning-by-doing parts of the curricula. Just watching an experiment being performed at a remote facility does not cut it. The development of the "app-space" is critical – and it has to be attuned to the specific needs of the community (i.e. coupled with a formal needs-assessment procedure). If the "apps" are well-designed, they can provide health care support, as well. Some Issues that need consideration include the question *How is the issue of truancy checked?* Schools often serve as a first-response against child-abuse and negligence, and we might have some unintended consequences to the handing-over the education mission entirely to the family. In many rural communities, the schools can serve as the "de facto daycare" (e.g., both parents are off to work, while the child is at school). This fabric can be disrupted with online K-12 schools, so thought should be given to the risk and reward of any potential technological disruptions.

We need metrics to measure how well we are doing with community college education and training – similar to K-12 education assessment. Positives of the "Broadband Panacea" include the improved connectivity will facilitate a variety of asynchronous-learning opportunities. A large group of specializations/areas- of-study will benefit with improved access (e.g., Coursera, Cloudera, etc). Unlike the K-12 case where the schools could be viewed as "de facto daycare," on line learning opportunities will benefit parents during the after-hours (e.g., taking a class after the kids are in bed). Potential issues with the "Broadband Panacea" include the importance of

development of customized-apps/customized- training in this space (compared to K-12 education). These competencies are varied across the nation, and one-size-does-not-fit-all.

There is use for a variety of connectivity-technologies in workforce development. Web-portals for sales/advertising can use a low-bandwidth connection as an enabling-technology to realize the economic long-tail phenomenon. A case for the "Broadband Panacea" includes providing high-bandwidth connectivity to rural communities will help individuals that can telecommute. The presence of a large community of telecommuters can influence the rural quality of life in many ways.

Research questions:

- What technology is sensitive to rural community culture that can make an impact and get adopted, not just for this generation, but for the upcoming one in schools?
- How can technology research and development support STEM education and creating a technologically savvy workforce in rural areas?
- What can digital technology do for different communities? How can you seed and support new economies (e.g., rural tourism) to take advantage of it?
- How can you change the rural culture towards entrepreneurship? What non-traditional avenues exist and how can technology development support engaging rural participation in entrepreneurship?
- What are success stories that transformed communities as a solution to a problem?
- How can we take advantage of data science on what the communities can do?
- How do we scale what worked into more environments?
- How can science experiments be customized to local environments?
- How can we build the long tail of rural communities?
- What are catalyst projects that can unfold possibilities, create a sense of identity, and seed strong connection to technology, e.g., taking advantage of the gaming industry?
- How can we treat rural communities as users of intelligent systems that we can learn about them over time?
- How can we take advantage of social media and crowdsourcing for data collection on rural communities?
- How can we treat rural communities as a system of systems or complex systems that education also depends on other issues, e.g., related to health, connectivity, and transportation?
- What are the core courses or competencies for rural communities?
- How can we build methods to encourage partnerships between rural communities and other rural communities and/or metro areas?

C. Public Safety and Emergency Responses: Session Chair -- Karen Rheuban

Subject matter expert speakers:

J. Gochal (NFPA)
Y. Wan (UT-Arlington)
A. Arora (Ohio State)

Breakout session moderators/reporters:

S. Roy (WSU), K. Wismer (NTCA)

L. Ratliff (UW), H. Rose (FHWA)
H. Alemzadeh (UVA), Y. Wan (UT Arlington)
T. Atkison (Alabama), G. Youtsey (U*C)*

Summary:

Session 4 explored public safety and emergency responses in rural communities. Issues surrounding public safety and emergency responses are multifaceted, integrally linked to other rural development topics, and are often exacerbated due to lack of infrastructure, access to communication and information network, and sparsely available resources. In addition to the key challenge of reducing response time in case of emergency, "preparedness/prevention" is also critical. Statistics collected by the National Fire Protection Association shows that while the number of home fires has fallen, the number of deaths per fire has not. Fires occur three times more often in communities less than 2,500 than those with population over 1 million (10.8 fires vs 3.1 fires per 1,000 people) and resulting in approximately 3.5 times more civilian fatalities (20.9 vs. 6 deaths per 1 million). Threats such as mudslides and wildfires are also unique challenges for rural communities further highlighting the need for prediction and warnings to reduce casualties.

Availability of emergency response resources in rural communities is a well-recognized challenged. Furthermore, the smaller the communities, the more they rely on all-volunteer fire departments (92.7% of communities with population less than 2,500 rely on all-volunteer fire department vs. 44.8% for communities with population from 5,000 – 9,999). The rate of people joining volunteer fire departments is also in steady decline, which accelerates the loss of institutional knowledge in rural communities.

Data analytics can be provide strong support for prevention and emergency services. Modeling and prediction can significantly enhance prevention and preparedness, and risk analysis can support resource allocation and planning. Technologists and social scientists can work together to identify high-risk communities to prioritize investment. Visualization (e.g., flooding or fire simulation) can also be a powerful tool to support outreach and advocacy. More effective sensing technologies can support immediate assessment of structures and infrastructures in case of emergencies.

To have effective data analytics, data must be available and accessible. Proper technology, tools, and policies must be developed to protect data privacy, integrity, and support timely analytics.

The advent of social media are resulting in new opportunities for emergency responses. Several examples were cited of citizens organizing or providing emergency aid through social media communications. However, social media is not without pitfalls. Examples include overhype leading to mass congregation causing gridlock. Being able to parse trustworthy information from constant stream of information is a recurring challenge, which is especially exacerbated in emergency situations.

Infrastructure is needed to provide the public with most up-to-date but also relevant information. For example, mass alerts (instead of targeted) may result in alert-fatigue. A well-integrated system and policies for public interaction is key.

A strong communication infrastructure can support large-scale monitoring and also handle high volume of traffic during emergencies. Rural areas often lack this infrastructure.

Therefore, new approaches to relay information across heterogeneous platforms, or leveraging ubiquitous technologies and services (e.g., apps) to support communications are needed.

In addition to challenges, there are advantages due to characteristics of rural environment that can be leveraged for public safety and emergency responses, including:

- Comparatively simple access to low-costs rights of way for delivering services (including Internet, water, locally-sourced renewable energy, etc.)
- Smaller municipalities, resulting in possibly being more responsive to new solutions.
- People are more aware of one another nearby than those in urban settings, this knowledge can be leveraged in emergency situations.
- Rural environments often have less “noise”, which enhances sensor effectiveness.

Research questions:

- How can research enable the sharing of data and analytic tools in low-resource (lacking advanced cyber infrastructure and technical expertise) settings?
- How do we protect data AND meet compliance requirements for small municipalities and communities?
- How can social-media driven responses in the community after (or in anticipation) of major event be better managed?
- How can apps be leveraged to enhance warning, with respect to both collecting (crowd sourcing) information and disseminating information?
- How do we design and implement better workflow to handle, disseminate data in acute emergency systems (e.g., active shooter at school) to balance timely access to relevant data and preventing mass hysteria?
- Public emergency alerts (e.g., flash flood, active shooter) are useful, however, over alerting can cause user fatigue (i.e., the receiver ignoring alerts). How do we design an integrated system linking prediction modeling with timely and relevant alerts to reduce fatigue?
- How to coordinate *orderly* evacuation via reverse 911 systems?
- Large scale monitoring systems suffer from lack of communication infrastructure. What are new protocols that can support message-hopping across heterogeneous technology platforms?
- How do we leverage the latest in material technology and integration with the local environment to design sensors and systems that are minimally invasive?
- How can we improve reliability of ad-hoc communication channels (e.g., social media, shortwave radios) for emergency communication and coordination?
- How can smart technology replace loss of institutional knowledge? Beyond preserving information, can ‘intelligent’ approaches be leveraged for training?
- How can we integrate different public services to support public safety and emergency response? e.g., leveraging public utility, street lighting, or waste collection to monitor public safety.
- Unmanned aerial vehicles (UAV) have clear advantages for emergency responses (e.g., reaching remote places, support ad-hoc communication, etc.). However, further research to improve mechanical capabilities/ reliability as well as regulations/policies are needed to increase adoption.

- What new approaches can accelerate virtualization/visualization of physical structures and infrastructures (e.g., buildings, bridges) where access to this information is not available, or take a long time, in rural settings?
- Can smart infrastructure monitoring technology support prevention and response? E.g., can buildings analyze occupant behaviors to predict emergencies?

D. Rural Health and Well Being, Session Chair – T. Nguyen

Subject matter expert panelists:

E. Brown, Successes and Challenges - California Telehealth Network
R. Helton, Health Wagon – Healthcare in Appalachia/ Drone Medical Delivery
G. Kurillo, UC Berkeley – Augmented Telemedicine
K. Rheuban, UVA Telemedicine

Breakout session moderators/reporters:

M. Walker/K Taylor
J. Sprinkle/N. Ait -Doud Tiouririne
R. Kavasseri/K. Wibberly
D. Cattell-Gordon/S. Schroeder

Summary:

Panel presentations focused on innovative approaches to healthcare access and quality care delivery models enabled by advanced technologies. Framed in the context of significant challenges faced by rural Americans and current and future technology solutions enabled by telecommunications technologies, panelists spoke to the existing evidence and models for innovation and the important linkage to public policy to sustain these models.

Rural patients face challenges in access, quality, and cost at far greater rates than their urban counterparts, attributable to a host of factors. Health status indicators tend to be worse in rural communities. This is attributable to economic, geographic and sociodemographic factors exacerbated by geographic isolation and an outmigration of younger citizens seeking employment and related health insurance coverage. “Core health care services” such as primary care, emergency medical services, long term care, mental health and substance abuse services, oral health and other services are considerably less accessible in rural communities. Rural hospitals are closing at record rates. A lack of access to specialty care services presents an equally significant challenge. In particular, the public health emergency of substance use disorder and opioid addiction compels us to embrace innovation for new methods of assessment and treatment. The aging of our population has already created increased the demand for specialty healthcare services to address both acute and chronic disease in the elderly. These challenges are worsened in rural communities. As an example, rural patients experience 25% higher death rates from ischemic heart disease than do their urban counterparts.

Rural communities in general lack sufficient patient volumes to support specialty and subspecialty practices. Primary care providers are often overwhelmed with complex patients with acute and chronic illness. Strategies to recruit and retain clinicians to practice in rural and frontier communities thus must also include innovative applications that enhance the management of patients with acute and chronic illness, and reduce the chronic sense of isolation experienced by

those practitioners by affording enhanced connectivity to colleagues and educational opportunities. Additional opportunities to bring augmented telemedicine services to EMS providers and to patients in the home setting require broadband connectivity still considerably lacking in many rural communities. One panelist spoke, based on actual experience, to the use of drone delivery of medications. Another suggested augmented care for EMS providers in remote locations using telementoring and/or even virtual reality approaches.

Telehealth technologies offer ready access to such services when rural communities and providers partner with tertiary and quaternary care facilities and where appropriate, with one another.

Telehealth can support patient engagement as well as medication adherence through remote patient monitoring programs. Telehealth allows for patients to remain within their community healthcare environment, resulting in a reduction in unnecessary transfers, less hospital lost revenue and the potential of enhanced economic viability of the community hospital. A viable community healthcare environment supports jobs, provides incentives for the relocation of industry, and enhances community economic development.

There appears to be confusion around, and little consensus on, the definition of:

- Rural
    - Who or what constitutes rural – is it general distance, population size, distance to health services, distance to health services and food/resources, etc.
    - Do Rural-Urban Commuting Area (RUCA) codes apply well to classify communities? What other methods area available?
    - Are we looking at a shortage of designations (not sufficiently fine-grained)?
    - Urban/Metro in North Dakota is not the same as urban in CA – this results in different needs for services and different barriers to care and quality care.
- Health
    - What does it mean to be healthy?
    - How do we measure health? Which indicators do we measure?
- Health quality
    - In rural areas, low sample size impacts quality measures
    - Payment is tied to quality of care in hospital/clinical settings
    - How is quality measured in rural versus urban hospitals?

Not all rural areas are created equal – one region of the U.S. may have higher mortality in a rural area while other regions have higher urban mortality. Therefore, we cannot have one model and would need community-based participatory research.

To have good health, wellbeing, and quality healthcare in rural areas, the community needs to be involved in decision making. This is the approach of the Community Health Needs Assessments.

A **Community Health Assessment** is required for all not-for-profit hospitals and public health units. Community Need Assessments involve all members of the community. They identify needs of the community based on county health data, economic data, population data, stakeholder meetings, etc. Questions not often included in the community surveys and stakeholder meetings are regarding connectivity and what the current capacity is in the

community, and where there are still needs. These needs assessments are an opportunity to determine if there are solutions using technology and connectivity that would address more than one of the community needs.

- We cannot take a top down approach when implementing smart and connected communities in rural areas. Practitioners should never bring a rural community a solution to a problem they have not identified. The community must be involved in identifying the need for the smart and connected community solution, and they must be able to assist in the strategic planning for the solution.
- Current need assessments in rural communities and for rural public health units (PHU) are conducted by for-profit organizations (often at high costs). Assessments are completed by the hospital/PHU itself, or are conducted by a third party not for profit (North Dakota model). They are not conducted a uniform fashion and some approaches are much better than others. Most are not multi-disciplinary and there is rarely someone involved in the stakeholder meetings with expertise in connectivity/technology/engineering. When communities are creating their strategic plan (after identifying community needs) there is opportunity to involve the technical experts to help rural communities identify solutions they may not be aware of. There needs to be a collaborative, multi-disciplinary, team approach to develop smart and connected rural communities.
- Regarding connectivity – a community needs assessment is important, and will drive solutions for a broad range of stakeholders (healthcare facilities, patients, farms, education, commerce)

CONCLUSIONS

The CRC17 workshop was highly successful in engaging all participants in conversations to learn about overarching challenges from presenters as well as deep-diving in breakout sessions to explore practical issues and best practices. Workshop attendees came to consensus on the critical importance of developing an effective Smart and Connected Communities research agenda to overcome challenges in under-connected communities. If this is not done, these communities will suffer greatly by missing the technological smart worlds revolution taking place. Research efforts must bring together diverse stakeholders and engage community participation early on. Problems must not be solved in isolation, and technical solutions must account for the economic, cultural, social, religious, and environmental characteristics of these rural communities. The research community joined in a *call to action* for the federal government to create and implement programs and policies specifically targeted at serving the under-connected population.

APPENDICES

WORKSHOP AGENDA

2017 National Workshop on Developing a Research Agenda for Connected Rural Communities (CRC17)

September 7 – 8, 2017 | Charlottesville, VA USA | Omni Hotel

Day 1 | September 7, 2017	
7:30 AM - 8:30 AM	**BREAKFAST + Networking**
8:30 AM - 8:50 AM	**Welcome remarks by organizers** *Karen Rheuban (UVA Telemedicine) and John Stankovic (UVA CS)* *David Corman (NSF)*
8:50 AM - 9:30 AM	**Session 1: Keynotes** Keynote 1: **Karen Jackson**, *Secretary of Technology, Commonwealth of Virginia* Keynote 2: **Peter Norton**, *Dept. of Engineering and Society, University of Virginia*
9:30 AM - 10:10 AM	**Session 2A: The Art of the Impossible: Bridging the Information Gap** **Chair: John Stankovic (UVA)** ***Rural Broadband: Reality, Challenges, and Opportunities*** *T. Nandagopal (NSF)* ***Municipal Information System*** *B. Patterson (City of Ammon, ID)* ***Rural Economic Development*** *R. Gallardo (Purdue)* ***Q&A Session (10 minutes)***
10:10 AM - 10:30 AM	**BREAK + Go to Breakout Discussions**
10:30 AM - 11:30 AM	**Session 2B: Breakout Discussions** ***BR1:*** *E. Zegura (GA Tech), T. Swartzwelder (K&Q County)* ***BR2:*** *S. Das (MST), L. Seuffert (SCHEV)* ***BR3:*** *R. Davis (USDA), L. Killey (Merit)* ***BR4:*** *L. Barnes (UVA), J. Mokros (Maine Math & Science)*
11:30 AM - 12:00 PM	**Reconvene, Breakout Discussion Reports**
12:00 PM - 1:00 PM	**LUNCH**
1:00 PM - 1:40 PM	**Session 3A: Social Considerations, Education and Workforce Development** **Chair: Jon Goodall (UVA)** ***Workforce Development*** *B. David (Orange Co., VA)* ***Rural Education*** *R. Mahaffey (Rural Education & Community Trust)* ***Technology Empowering Community*** *U. Ramachandran (GA Tech)* ***Q&A Session (10 minutes)***
1:40 PM - 2:00 PM	**Go to breakout sessions**
2:00 PM - 3:00 PM	**Session 3B: Breakout Discussions** ***BR1:*** *E. Rozier (Iowa State), C. Qian (Weldon Cooper Center)* ***BR2:*** *M. Hoit (NCSU), R. Latimer (UVA)* ***BR3:*** *I. Altintas (UCSD), M. Kennedy (Kennedy Group)* ***BR4:*** *R.S. Sreenivas (UIUC), J. Cochran (W. VA)*

3:00 PM - 3:20 PM	**Break / Reconvene to Main Room**
3:20 PM - 3:40 PM	**Breakout Discussion Reports**
3:40 PM - 4:20 PM	**Session 4A: Public safety and emergency response** **Chair: K. Rheuban** ***Data Analytics and Information Sharing*** *J. Gochal (NFPA)* ***Coordinating and Emergency Response*** *Y. Wan (UT Arlington)* ***Mobility and Public Safety*** *A. Arora (Ohio State)* ***Q&A Session (10 minutes)***
4:20 PM - 4:30 PM	**Go to breakout sessions**
4:30 PM - 5:30 PM	**Session 4B: Breakout Discussions** ***BR1:*** *S. Roy (WSU), K. Wismer (NTCA)* ***BR2:*** *L. Ratliff (UW), H. Rose (FHWA)* ***BR3:*** *H. Alemzadeh (UVA), Y. Wan (UTA)* ***BR4:*** *T. Atkison (Alabama), G. Youtsey (UC)*
5:30 PM - 5:40 PM	**Break / Reconvene to Main Room**
5:40 PM- 6:00 PM	**Breakout Discussion Reports**
6:00 PM - 6:30 PM	**BREAK** *Prepare for dinner*
6:30 PM - 8:00 PM	**Dinner**
Day 2	
7:30 AM - 8:10 AM	**BREAKFAST + Networking**
8:10 AM - 8:30 AM	**Summary + Charge to Action** *John Stankovic (UVA)*
8:30 AM - 9:20 AM	**Session 5: Report from community initiatives** **Chair: Scott Midkiff (VT)** ***MainStreet21 @ UVA*** *M. El-Khafif (UVA)* ***US Ignite*** *G. Ricart (US Ignite)* ***MetroLab*** *B. Levine (MetroLab)* ***GCTC*** *- J. Rice (NTIA)* ***MOHERE @UW*** *R. Poovendran (UW)* ***Q&A Session (10 minutes)***
9:20 AM - 9:40 AM	**BREAK**
9:40 AM - 10:30 AM	**Session 6A: Rural Health and Well-Being** **Chair: Tho Nguyen (UVA)** ***UVA Telehealth Program: Successes and Challenges*** *K. Rheuban (UVA)* ***California Teleheath: Successes and Challenges*** *E. Brown (CalTelehealth)* ***Augmented Telemedicine*** *G. Kurillo (Berkeley)* ***Drone Medical Delivery*** *R. Helton (Healthwagon)* ***Q&A Session (10 minutes)***
10:30 - 10:40 AM	**Go to breakout sessions**
10:40 AM - 11:40 AM	**Breakout Discussions** ***BR1:*** *M. Walker (Southern Rural Dev.), K. Headrick Taylor (UW)* ***BR2:*** *J. Sprinkle (NSF), N.A. Tiouririne (UVA)*

	BR3: *R. Kavasseri (NDSU),* K. Wibberly (MATRC) **BR4:** *D. Cattell-Gordon (UVA), S. Schroeder (Health Gateway)*
11:40 AM - 11:50 AM	**Reconvene to Main Room**
11:50 AM - 12:10 PM	**Breakout Reports**
12:10 PM - 1:00 PM	**Lunch**
1:00 PM - 1:20 PM	**Summarize Breakout Reports Over Two Days**
1:20 PM - 2:20 PM	**Whole Group Discussion** • *Overarching Challenges: Short-Term, Long-Term* • *Key research questions* • *What works, what doesn't in community partnerships*
2:20 PM - 2:30 PM	**Wrap-Up / Next Steps -** *John Stankovic (UVA)*
2:30 PM - 5:00 PM	**Tour of UVA Cyber-Physical Systems Labs and Demos**

WORKSHOP ATTENDEES

First	Last	Institution
John	Cherniavsky	NSF
Nassima	Ait-Daoud Tiouririne	UVA
Homa	Alemzadeh	University of Virginia - ECE Department
Ilkay	Altintas	UC San Diego
Anish	Arora	Ohio State University and The Samraksh Company
Travis	Atkison	University of Alabama
Laura	Barnes	University of Virginia
Ila	Berman	University of Virginia
Eric	Brown	California Telehealth Network/OCHIN
Qian	Cai	Weldon Cooper Center for Public Service
David	Cattell-Gordon	Unviversity of Virginia Center for Telehealth
Donna	Chen	University of Virginia
Octav	Chipara	University of Iowa
Jill	Cochran	West Virginia School of Osteopathic Medicine
David	Corman	NSF
Sajal	Das	Missouri University of Science and Technology
Bryan	David	Administrator, Orange County
Rich	Davis	USDA Rural Development
Ibrahim	Demir	University of Iwoa
Marc	Doussard	University of Illinois at Urbana-Champaign
Mona	El Khafif	UVA
Jeff	Fox	UVA
Roberto	Gallardo	Purdue Center for Regional Development
Joseph	Gochal	NFPA
Jon	Goodall	University of Virginia
Meredith	Gunter	Weldon Cooper Center - UVA
Devin	Harris	University of Virginia
Rachel	Helton	The Health Wagon
Marc	Hoit	NC State University
Meghan	Houghton	NSF
Denise	Hubbard	UVA

Ronald	Hutchins	UVA
Srikanth	Jonnada	Participant
Mary Lee	Kennedy	The Kennedy Group
Lola	Killey	Merit Network, Inc.
Predrag	Krajacic	West Virginia School of Osteopathic Medicine
Gregorij	Kurillo	University of California, Berkeley
John	Lach	UVA
Rebecca	Latimer	University of Virginia
Ben	Levine	MetroLab Network
Juan	Li	North Dakota State University
Qing	Li	Tongji University
Ryan	Locicero	National Science Foundation
Robert	Mahaffey	Rural Education and Community Trust
Scott	Midkiff	Virginia Tech
Jan	Mokros	Maine Mathematics and Science Alliance
Andrew	Mondschein	UVA School of Architecture, Urban and Environmental Planning
Chowdhury	Moniruzzaman	UNC Chapel Hill, Institute for the Environment
Suzanne	Moomaw	University of Virginia
Thyaga	Nandagopal	National Science Foundation
Tho	Nguyen	UVA Dept. of Computer Science
Shahriar	Nirjon	UNC Chapel Hill
Pamela	Norris	University of Virginia
Bruce	Patterson	City of Ammon, ID
Radha	Poovendran	UW Electrical Engineering
Umakishore	Ramachandran	Professor, College of Computing, Georgia Tech
Fred	Ramey	City of Norton
Lillian	Ratliff	Asst. Prof. University of Washington
karen	rheuban	UVA Center for Telehealth
Glenn	Ricart	US Ignite and U. Utah
Jean	Rice	National Telecommunicaitons and Information Administration
Heather	Rose	FHWA Office of Policy

Sandip	Roy	Washington State University
Eric	Rozier	Iowa State University of Science and Technology
Shawnda	Schroeder	Center for Rural Health, University of North Dakota
Lynn	Seuffert	State Council of Higher Education for Virginia
Simone	Silvestri	University of Kentucky
Houbing	Song	Embry-Riddle Aeronautical University
Jonathan	Sprinkle	National Science Foundation
Ramavarapu "RS"	Sreenivas	University of Illinois at Urbana-Champaign
Jack	Stankovic	UVA Dept. of Computer Science
Tom	Swartzwelder	King and Queen County Broadband
Steven	Thomson	USDA NIFA
Robert	Tse	USDA California Rural Development
Martha	Walker	Virginia Tech / Virginia Cooperative Extension
Yan	Wan	University of Texas at Arlington
Kathy	Wibberly	Mid-Atlantic Telehealth Resource Center
Ronald	Williams	University of Virginia
Kelly	Wismer	NTCA - The Rural Broadband Association
Dan	Work	University of Illinois at Urbana Champaign
Gabriel	Youtsey	University of California Agriculture and Natural Resources
Chad	Zanocco	Oregon State University
Ellen	Zegura	Georgia Tech
Li	Zhang	Tongji University
Min	Zhao	Tongji University
Ting	Zhu	UMBC
Tae	Hong Park	NYU
Jing	Gan	Tongji University
Ridwan	Alam	UVA
Lei	Pang	Tongji University
John	Cherniavsky	NSF
Elahe	Soltanaghaeri	UVA (Student)

LINK TO RELATED COMMUNITY REPORTS AND RESOURCES

- Available for download at the workshop website: https://cps-vo.org/node/36076/browser
    - Purdue Center for Regional Development, “Broadband Impact”
    - NTIA 2012 report on “The Smart Rural Community”
    - May 2017 NTCA Comments on Broadband-Enabled Health Care Solutions and Advanced Technologies
    - May 2017 NTCA examples of member success stories in healthcare
- USDA 2016 Rural Development Community Facilities Infrastructure Toolkit: https://www.rd.usda.gov/files/RDCFIToolkit_Jan2016.pdf
- Smart rural communities initiative: www.ntca.org/smart
- Rural health research gateway: https://www.ruralhealthresearch.org/
- 2014 update on the urban-rural chartbook: https://ruralhealth.und.edu/projects/health-reform-policy-research-center/pdf/2014-rural-urban-chartbook-update.pdf