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Practical Approaches and Proposed Strategies for Measuring Selected Aspects of Community-Based Broadband Deployment and Use

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A series of studies of rural Florida community anchor institutions have concluded that existing national measurement practices for broadband penetration, adoption, and impact are often poorly defined, confusing, or inadequate to inform decisions about community broadband deployment and adoption. As a result, local broadband initiatives may be hindered by "measurement confusion." This article proposes the Broadband Readiness Index (BRI) with a number of broadband readiness criteria and the Community-Based Broadband Planning, Adoption, and Deployment model (CBBP) to address this confusion and position local officials to better coordinate, deploy, and use broadband locally; demonstrate how improved high-speed broadband affects their communities over time; and sustain planning for continuous improvements of community broadband use.

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Practical Approaches and Proposed Strategies for Measuring Selected Aspects of Community-Based Broadband Deployment and Use

A series of recent studies conducted by the Information Use Management and Policy Institute (the Institute) at the Florida State University[2] revealed that local officials often found existing measures of broadband penetration, adoption, and impact difficult to understand and impractical. This has hindered community broadband initiatives and resulted in initiatives with undocumented successes.

Realistic measurement options and solutions can alleviate local officials' confusion about how to measure broadband in their communities and at their community anchor institutions (CAIs). To this end, this paper presents two strategies for measuring broadband that local community officials can employ easily. The Community-Based Broadband Planning, Adoption, and Deployment model (CBBP) serves as a guide for local community officials on how to plan for broadband deployment; develop, implement, and use broadband and broadband-enabled applications; and assess broadband deployment and adoption in their communities. The Broadband Readiness Index (BRI) contains nine criteria, such as the availability of trained information technology (IT) staff and quality of network and computing equipment, for measuring the readiness of a community, organization, or institution that local officials can use as a guide for broadband deployment and measurement. The CBBP and the BRI can be used either separately or in combination to enhance community members' understanding of broadband, increase their willingness to adopt broadband, and create awareness of broadband's benefits.

This article will present a review of selected literature regarding broadband measurement at the national level, followed by a summary of findings from the studies of rural Florida CAIs that resulted in the findings that shaped the BRI and the CBBP. The article also describes next steps for field-testing the two proposed strategies. In addition to the potential contributions that better measurement practices and planning/evaluation models will make to the academic community, this paper is targeted at local officials charged with leading efforts to deploy and measure the impact of broadband in their communities. Findings from the CBBP and BRI field tests may provide community broadband decision makers with data and strategies to improve broadband deployment and use in their communities.

Selected Literature Discussing National Measures and Reporting

Each spring, researchers from the Pew Research Center's Internet & American Life Project conduct a survey designed to assess broadband adoption by Americans and "probe the attitudes and experiences of those who do not use broadband" (Smith, 2010, p. 5). Smith (2010) reports that, as of May 2010, 66% of American adults had a high-speed broadband connection at home and that, although this percentage has grown in the United States, some segments of the population are not part of the broadband adoption story. Results of the Institute's studies of rural Florida communities are congruent with the Pew Research Center's survey findings. In two studies of broadband connectivity and use at rural

[2] All the studies, reports, and papers can be found on the Institute's website at www.ii.fsu.edu

Florida CAIs, Mandel, Alemanne, and McClure (2012) find that myriad situational factors affect broadband adoption, including administrative support, funding, broadband availability, and understanding broadband and its importance. They conclude that understanding the enablers and barriers to broadband adoption in CAIs is critical to achieving widespread broadband adoption.

Limitations in Current Broadband Measurement Practices

Broadband measurements may be hindering local officials' understanding of broadband adoption in their communities. These measurements may be designed to inform national- and state-level policy makers or other researchers, but they are not necessarily intended to inform the local officials responsible for implementing broadband in their communities. The literature includes numerous questions about measurement approaches in various areas such as the definition of broadband, actual broadband needs, and the roles of computer quality, cost, and lack of knowledge about workstation connection speeds.

Researchers have found that a key metric affecting users' experiences with broadband is advertised versus delivered speed (Whitt & Lampert, 2009). To address the question of actual workstation broadband speeds, a consumer could take one of the many, readily available speed tests. These tests purportedly allow consumers to know their download and upload broadband speeds. However, measurements of workstation speeds depend on which test is used (because each relies on a different method for calculating speed), the time of day the test is taken (because network traffic impacts relay time between the workstation and the test server), and other local and network factors.

According to Bauer, Clark, and Lehr (2010), "broadband speed has emerged as the single most commonly cited metric for characterizing the quality of broadband offerings" (p. 5). Their study compares the different methods for calculating speeds used by popular speed testing tools and finds variation among the results. While Bauer et al. do not conclude that there is a single method for measuring speed that is appropriate for all contexts, they suggest that having fewer, generally accepted methods with clear documentation would aid in data aggregation, analysis, and interpretation.

The Federal Communications Commission's (FCC's) 2010 national random digit dial telephone survey of adults found that nearly half of consumers (49%) report a delivered speed that is *not always* the same speed for which they pay (Horrigan & Satterwhite, 2010). Additionally, 80% of consumers do not know the advertised speed of their home connections, and 71% believe that their home broadband connection speed is as fast as the speed that the Internet service provider (ISP) promised at least most of the time. This lack of consumer awareness about these basic elements of broadband performance led the FCC to recommend several initiatives to improve information available to consumers in the *National Broadband Plan* (*NBP*) (FCC, 2010).

Speed represents only one type of broadband measurement. Another important category is use pattern. The Organisation for Economic Co-operation and Development's (OECD's) broadband portal (http://www.oecd.org/sti/ict/broadband) provides statistics of broadband penetration and usage, but current OECD tools do not take into account different use patterns among households (Beard, Ford, Spiwak, & Stern, 2010). Because the OECD measures broadband adoption per capita (OECD, 2010),

measurements of broadband adoption can be inaccurate or misleading since multiple users generally share the Internet connections in homes and businesses. A household with four people and a business with 100 employees would show a per capita adoption rate of 1.92% (two connections per 104 people), yet really all 104 people have adopted broadband.

Another challenge to measuring broadband adoption and use is the limitations of the broadband data collected by the FCC on Form 477. According to Kolko (2010), the only comprehensive published indicator of residential broadband availability in the United States is the number of ISPs per ZIP code as reported by the FCC, although it is widely accepted that these data are flawed, often misinterpreted, and insufficient for understanding the market for high-speed Internet services. As an alternative, Kolko introduces a measure of residential broadband availability that takes the average implied availability across all ZIP codes in the area, weighted by the number of households in each ZIP code. However, this measure also provides challenges for measuring broadband adoption and use, because it is not clear what "average implied availability" means.

Current statewide broadband mapping initiatives, which rely on FCC Form 477 data and other ISP-provided data, assume that ISPs are providing truthful data and that when an ISP says broadband is *available* in an area, that leads to adoption. These efforts mostly do not include actual measures of adoption, such as number of actual subscribers, speeds for which they pay, and speeds they actually experience at the workstation, and they do not include measures of the impacts and outcomes of the broadband stimulus. Also, there is a lack of agreement on benchmarks for measuring impacts of broadband on a statewide level (Visser & Ball, 2010).

The U.S. Census measures broadband adoption per household using a stratified random sample on its Internet Use Supplement, which frustrates comparability with FCC and OECD data. The Internet Use Supplement includes data that reflect the type of Internet connections respondents utilized at home and other sites of Internet use. Using these data, one can identify households, but not necessarily individuals, who use broadband Internet at home to connect to the Internet. The sampling strategy also means that small towns and rural communities often are projected based on estimated population, not actual participant counts (Steffey, 1997). Projection is not proportional and may lead to an underrepresentation of rural residents in U.S. Census data (Winkler, 2009).

The lack of consistency in broadband definitions, inadequate competition measures, and imprecise indicators of speeds suggest that the United States lacks current, accurate, and consistently calculated granular data about broadband (Flamm, Friedlander, Horrigan, & Lehr, 2007). Also, "failure to measure ICT [information and communication technology] inputs or ICT-derived outputs correctly contributes to measurement problems, making it difficult to observe quantifiable ICT impacts" (Crandall, Lehr, & Litan, 2007, p. 4). The examples in this section illustrate the need for expanded empirical testing about broadband impacts and outcomes that are *easily measurable at the local level* so that local officials are better able to make informed choices about broadband adoption and deployment.

Identification of Measurement Responsibility

The Corporation for Education Network Initiatives in California (CENIC) developed a self-assessment guide to help communities determine broadband readiness and outcomes (2005). CENIC also supports readiness assessment as an initial step of planning. The CENIC guide reflects the views of other researchers who point out that planning and measurement must be tailored to local circumstances, due to the fact that relatively short geographic distances can result in significant differences in availability and quality of service (Flamm et al., 2007; Horrigan, 2007). Goldman (2009) extends this argument by defining a local community in a geographic, demographic, or economic context. Separate benchmarks for homes, public institutions, rural Americans, low-income populations, and so on may provide the most meaningful measurements of broadband.

Currently, a main stakeholder in local broadband policy and decision making is the federal government. The FCC argues that the government should invest in rigorous evaluation of its broadband investments and that those "evaluations must provide a clear framework against which programs can be measured" (2010, p. 183). For more than 20 years, the U.S. has had a national policy goal of universal and affordable broadband. However, current government data collection efforts do not allow assessment of whether this goal is met (Flamm et al., 2007).

Industry and consumer representatives also have roles to play in the development of measurement standards at the local level (FCC, 2010). The FCC with the National Institute of Standards and Technology have recommended (Recommendation 4.3) that ISPs and related commercial organizations establish technical broadband measurement standards and a process for updating them to give consumers a more accurate view of broadband service performance (FCC, 2010). These measures might include actual speeds and performance: over the network and end-to-end; at peak usage hours; achieved with a given probability over a set period of time, including peak usage times; and tested against a given set of standard protocols and applications.

Key Elements of Existing Measurement Models

The Benton Foundation suggests that one way to measure the effectiveness of community broadband projects is to determine whether they affected the whole community, focused on training and workplace applications, or just built broadband infrastructure (Benton & Williams, 2009). The idea is to investigate the outcomes of broadband use in communities, such as capital flows, labor markets, population distributions, governmental services, and community participation. These outcomes might be measured via indicators such as frequency, place, and types of use; devices; connection types; attitudes; and discourse (Golston, 2009).

In the *NBP*, the FCC strongly supports the need for measuring outcomes as indicators of programmatic success. Bertot and McClure (2007) argue that it is necessary to move beyond simple measures of speed to assessing the sufficiency and quality of bandwidth to support networked services and resources, particularly in CAIs that support multiple, simultaneous users on one network. This

requires measuring speed along with budget, sustainability, staff and support, services, and impacts of technology services on communities. A shift to outcomes-based evaluation requires the development of indicators that measure how technology resources in CAIs "affect the social, economic, personal, and/or professional wellbeing of individuals, families, and communities" (Becker, Crandall, & Fisher, 2009, p. 111).

Measuring Broadband Locally: An Example from Rural Florida Communities

The Institute conducted two concurrent needs assessments of broadband connectivity for the North Florida Broadband Alliance (NFBA) and the Florida Rural Broadband Alliance, LLC (FRBA), projects in rural Florida. These projects shared a primary goal of bringing middle mile broadband infrastructure to Florida's three Rural Areas of Critical Economic Concern (RACECs). Each RACEC is comprised of 6 to 14 rural, economically depressed counties.[3] Each project included needs assessment, benchmarking, and on-site diagnostics of the broadband at rural CAIs and employed a multi-method approach: a Web-based survey, focus groups, and on-site diagnostics at selected CAIs (Mandel et al., 2012).

For each project, the Institute first conducted a Web-based survey of all CAIs in each RACEC. The study team determined that it was feasible to use the entire population of CAIs rather than a sample. NFBA CAIs returned 123 surveys (out of 368 sent out), and FRBA CAIs returned 82 surveys (out of 347 sent out), for a 28.7% total response rate for all Florida RACEC CAIs. The team analyzed survey results using descriptive statistics, such as frequencies and cross-tabs.

Following the survey, the team conducted six focus groups in the NFBA service area and five in the FRBA service area with 78 total participants for all focus groups. The team analyzed the notes from each area to identify recurring themes emerging from participants' comments. Finally, the team performed on-site diagnostics at 14 CAIs in NFBA and 19 CAIs in FRBA. The team analyzed data from the on-site diagnostics, such as advertised versus realized speeds and availability of IT personnel using descriptive statistics, and reviewed notes from the accompanying interviews for themes. The following sections contain selected findings from the NFBA and FRBA projects. Full findings from both projects are available.[4]

Indicators of Deployment and Availability

Participants reported a broad array of Internet connectivity types and costs from a range of ISPs. Actual connection speeds ranged from dial-up speeds to more than 20 Mbps, and CAIs reported a wide variety of advertised speeds from various ISPs.[5] The assessments also showed a wide range of geographic differences between the NFBA service area, located between Tallahassee and Jacksonville in north Florida,

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[3] The RACECs are depicted at http://www.eflorida.com/FloridasFuture.aspx?id=2108

[4] The final reports of both projects are available at http://nfba.ii.fsu.edu/reports and http://frba.ii.fsu.edu/reports

[5] See Table 1 in Mandel et al. (2012) for a comparison of advertised and actual speeds.

and the FRBA service area, which includes counties in the rural north Florida panhandle and the south-central Everglades area.[6]

Participants related a number of difficulties regarding getting connected, negotiating contracts, obtaining reliable service, and so on. One participant commented that he attempted to improve his institution's connection by adding another DSL connection line, but the ISP provided only one IP address, thus nullifying any increase in speed. Others reported that there were parts of their counties where residents barely receive landline phone service and cannot get cable television connections, to say nothing of Internet connections. This lack of availability reflects a concern shared by many of the focus group attendees whose institutions serve users who need to access services from their homes (e.g., hospitals, schools, libraries, and cities and counties with e-government services); improved speeds to the CAI will not mean as much without concurrent adoption of residential, high-speed broadband.

Indicators of Broadband Speeds

While speed is not the only indicator of broadband performance, it is a measure that many people (ISPs included) emphasize. The NFBA and FRBA needs assessment surveys measured both advertised speed and at-the-workstation speed. The survey also included questions on the CAIs' use of firewalls, filters, and Wi-Fi (whether they were available and the degree to which they affect network speeds) and the number of wireless access points on their networks to ascertain network management practices that may have affected the speed measurements.

Survey respondents reported advertised speeds and used a free speed test to measure speeds at a staff and a public workstation (for CAIs that had public workstations). Because the surveys constitute self-reported data, it is not possible for the study team to know at which time(s) of day the respondents conducted these speed tests. At times, the differences were stark. For example, 27.6% of NFBA CAIs reported advertised speeds faster than 10 Mbps (to the front door), but only 16.9% of NFBA CAIs experienced that speed *downstream* at a *staff* workstation, and even fewer (8.7%) experienced that speed *upstream* at a *staff* workstation. The same discrepancies were true for FRBA CAIs, with 32.9% of FRBA CAIs reporting advertised speeds faster than 10 Mbps, but only 16.7% experiencing that speed *downstream* at a *staff* workstation and 9.0% experiencing that speed *upstream* at a *staff* workstation. The study team conducted speed tests at two points during each on-site diagnostics visit, once in the beginning and once at the end. Half of the visits were in the morning and half in the afternoon, and all speed tests occurred while users were on the network. Nevertheless, findings mirror the data reported in the survey, with the team observing speeds faster than 10 Mbps at only two of the 14 NFBA diagnostics sites and two of the 19 FRBA diagnostics sites.

The disparity between advertised speed and at-the-workstation speed is even more pronounced when looking at public workstations. Here, too, because the survey constitutes self-reported data, it is not possible to know how many users (staff and public) were utilizing the network during the testing, but it is unlikely that tests occurred at no-load conditions. While 49.0% of NFBA CAIs reported advertised speeds

[6] See the NFBA and FRBA reports for maps displaying these comparisons.

faster than 5 Mbps, in actuality, 76.3% experienced *downstream* speeds of 5 Mbps or slower at *public* workstations and 87.2% experienced *upstream* speeds at or below 5 Mbps at *public* workstations. Again, this discrepancy appears at FRBA CAIs as well: 63.3% of FRBA CAIs reported advertised speeds faster than 5 Mbps, but actual speeds were substantially slower, with 85.1% of FRBA CAIs experiencing speeds at or below 5 Mbps *downstream* at *public* workstations and 88.8% experiencing *upstream* speeds of 5 Mbps or slower at *public* workstations.

Indicators of Broadband Use

Respondents identified the services for which the public uses broadband at their institutions from a set list. Educational resources and databases (85.1%), e-mail (71.6%), and e-government services (66.2%) dominated public use of the Internet at CAIs. Services for job seekers (55.4%), community information (52.7%), social networking (51.4%), and computer and Internet skills (47.3%) were also popular.

Another indicator of broadband use is the degree to which existing connections meet staff and user needs. While the majority (78.0%) of CAIs in NFBA and FRBA reported that their Internet connections met staff needs all or most of the time, roughly one–fifth (22.0%) of CAIs had Internet connections that only met staff needs sometimes, rarely, or never. CAIs reported that their Internet connection met the public's needs at similar rates, although slightly fewer (72.2%) reported that the Internet connection met public needs all or most of the time.

Indicators of Enablers and Barriers to Broadband Adoption

In addition to measures of broadband and availability, a key finding from the NFBA and FRBA studies was the need to identify and measure enablers and barriers to broadband adoption. The study team identified these factors through the survey, focus groups, and diagnostics, making them relatively easy for community officials to understand. For example, the survey asked about whether CAIs offered wireless Internet to staff (95.9%) and/or public (43.4%) users, and whether they were planning to add wireless services in the near future (35.6% of CAIs that currently lack Wi-Fi). A plan to add or increase wireless service could enable broadband adoption, since a faster broadband connection allows the same network to serve more users at higher speeds simultaneously. Factors that may act as barriers include cost (ongoing maintenance cost and Internet service cost), availability of ISPs, availability of trained IT personnel, and technical issues. More than half of the responding CAIs cited all of these factors as being extremely or very important obstacles to obtaining broadband or increasing speed. Focus group and on-site diagnostic participants also noted these factors as barriers to broadband adoption.

Indicators of CAI Broadband Readiness

The FRBA and NFBA on-site diagnostics and focus groups were especially informative about the extent to which a particular CAI was ready to better exploit high-speed broadband. Clearly, the readiness of a CAI to improve its use of broadband depends on a host of organizational, community, and ISP factors. But the analysis of data from these activities identified a preliminary list of nine factors that help

determine which CAIs might be targeted first for new or upgraded broadband services and others that might require increased broadband awareness and training before obtaining new or upgraded broadband service. These criteria that describe CAI readiness to adopt broadband are discussed in more detail later, in the section on the Broadband Readiness Index.

Proposed Solutions for Measuring Broadband in Communities

The selected literature discussed above that includes ambiguities and confusion with *national* measures of broadband deployment and use also causes ambiguities and confusion at the *community* level. Indeed, the study team found that local community leaders' eyes "glazed over" when detailing aspects of the *NBP* about deployment, measurement, and related issues. The community leaders' concern was solving broadband problems in their communities, not measuring national broadband deployment, speed, or jobs creation.

This article does not offer a review of literature on community-based broadband planning and broadband measurement. In general, the literature includes only limited material on this topic and less on community-based broadband impacts and outcomes measures. For example, Settles (2010) offers a useful guide for one approach to community-based broadband planning but does not include an evaluation or measurement component.

The Virginia Office of Telework Promotion and Broadband Assistance made a *Broadband Toolkit* (2011) available "to serve as a roadmap for communities seeking to obtain affordable last mile broadband services through a community influenced model" (p. 1). The Rural Telecommunications Congress also developed a *Community Toolkit* for "communities . . . seeking to obtain affordable last mile broadband through a community-influenced model" (2011, p. 1) based largely on the Virginia *Broadband Toolkit* and other available resources. While these and other community-focused resources are useful, they are not comprehensive, and they provide limited detail on specific steps for determining a community's readiness for broadband, implementing a community-based broadband plan, and operationalizing measures for gauging successful community-based broadband deployment and use. In addition, the degree to which these and other such sources based their development on empirical evidence is not clear.

From the FRBA and NFBA findings discussed above, the Institute developed two broad approaches for measuring broadband readiness, deployment, adoption, use, and outcomes at the *community* level. The first step is for communities to assess anchor institutions' readiness to adopt broadband. This approach utilizes a Broadband Readiness Index that measures readiness according to nine criteria. The proposed Community-Based Broadband Planning, Adoption, and Deployment model begins with understanding the community base and the community's enablers and barriers, then moves into planning and deployment, followed by measuring impacts and outcomes. The CBBP is a more comprehensive approach to the entire broadband deployment and adoption cycle, whereas the BRI is a beginning step to measure a community's or CAI's readiness to adopt broadband.

These approaches are based on findings from the FRBA and NFBA studies and especially draw upon on-site broadband diagnostics, focus groups, and individual conversations with participants for what

they needed to better deploy broadband. A brief description of these approaches follows. The intent is to provide a practical, straightforward set of strategies to assist local CAIs, other organizations, and community opinion leaders to better access, deploy, and use broadband throughout their communities. After the Institute field-tests and refines these approaches, committed groups of community leaders can employ these strategies to improve broadband deployment and use in their communities.

Broadband Readiness Index

One of the only national broadband readiness indexes, Connected Nation's Broadband Readiness Index, uses the National Telecommunications and Information Administration's National Broadband Map county data to focus on three key metrics: wire line capacity at basic speeds, mobile wireless access, and high-capacity speeds greater than 50 Mbps (Connected Nation, 2011). However, the index may not take into account all the factors necessary to measure and identify local challenges and to promote action with regard to adopting and utilizing broadband. Many readiness indexes recognize the importance of broadband internationally, such as the ICT Development Index (IDI) and the ICT Price Basket. "The IDI for example, includes several broadband-related indicators like mobile- and fixed-broadband penetration, international Internet bandwidth and Internet use; and the ICT Price Basket has a sub-basket that measures the cost and affordability of fixed-broadband access" (International Telecommunications Union, 2011, p. 85). In contrast, this article, the BRI, and the CBBP focus on a community-based approach.

From the findings of the NFBA and FRBA studies, the Institute developed a new BRI that measures the readiness of CAIs to adopt broadband. The BRI is based on nine criteria that take into account different situational factors under which CAIs operate and are meant to assess the readiness of an institution to adopt and utilize broadband. The degree to which an institution meets each criterion is assessed according to a three-point scale: high, somewhat, or low ability. The index requires both publicly available data and data that must be obtained from individual CAIs. Each criterion is broken down further into unique qualifiers intended to better predict the likely readiness of broadband adoption in the CAI.

Ability to change ISP. The ability to change ISPs is a critical situational factor affecting whether a CAI can adopt a broadband connection through a newly built middle mile or last mile network, fiber-to-the-premises, broadband over power line, or any other higher-speed technology than that to which the CAI already subscribes. Possible qualifiers for determining a CAI's ability to change ISPs include the degree to which: (a) the CAI can decide which ISP to contract with on its own, or another, higher-level organization controls that decision; (b) there is a selection process, such as bidding or recurring evaluation of service quality, for selecting ISPs at the CAI; (c) the current contract allows for change; (d) ISP availability is the primary qualifier for making the selection instead of a selection process; and (e) the current cost of service provision is higher than the expected cost of the new, higher-speed connection.

Available and trained IT staff. Available and competent IT staff in a CAI enable the other members of the staff to focus on their own tasks, provide administration with a reliable reference for CAI capabilities and needs, and conduct research on new applications that may provide a higher quality of service to clientele. Possible qualifiers for evaluating whether a CAI has available and trained IT staff include the degree to which: (a) the institution has its own IT staff member or members (yes, no, or

somewhat, with somewhat meaning that the CAI shares an IT staffer with a professional organization or county IT department); (b) the IT staff has sufficient years of experience; (c) IT staff have input into decision making about purchasing equipment, contracting with ISPs, and so on; (d) IT staff are responsive to network problems; and (e) IT staff have sufficient higher education and training to meet the CAI's needs.

Existence and quality of internal network. A CAI's internal network configuration is a major determining factor in its capability to adopt and fully utilize a broadband connection. Firewalls or poor configuration of workstation settings affect the ultimate speed of the connection reaching users and staff members as they attempt to complete tasks online. Possible qualifiers for evaluating the existence and quality of a CAI's internal network include the degree to which: (a) a firewall impacts the speed of an internal network; (b) schema with which workstations are configured on the network in a manner that positively or negatively impacts workstation speeds (for example, direct from the server to each workstation versus from the server to workstation A, then workstation B, etc.); (c) a local area network exists for staff members, either hosted on their own server or another provider's servers; (d) the CAI uses its own servers, either physical or remote; (e) wiring connecting equipment is organized to facilitate network traffic; and (f) a wireless connection is available.

Age of network and desktop equipment. The age of network and desktop equipment impacts a CAI's ability to fully utilize a broadband connection. Ideally, a CAI replaces equipment on a 3- to 5-year schedule, but often CAIs purchase new equipment when critical components fail. Possible qualifiers for determining the age of network and desktop equipment and the ability of the CAI to replace old equipment in a timely manner include the degree to which: (a) the majority of staff workstations are less than 5 years old; (b) the majority of staff workstations' operating systems are less than 5 years old; (c) servers (if any) are less than 5 years old; (d) routers, firewall, and switches are less than 5 years old; (e) other application equipment, such as video conferencing equipment, is less than 5 years old; and (f) the CAI has the ability to maintain a 3- to 5-year replacement schedule for equipment.

Sufficient funding. Funding for IT can be a fundamental problem for many CAIs. Many note that they are barely able to cover current costs and are unable to pay additional fees to break a contract or pay more for higher connection speeds or service quality. The structure of a CAI's funding also influences how budgets are allocated. If the CAI receives technical support from a parent organization or funding primarily through grants, for example, it might not be able to allocate funds away from one area toward technology to buy new equipment in order to use new or upgraded broadband. Possible qualifiers for determining the ability to procure adequate funding for broadband adoption and utilization include the degree to which: (a) portions of the annual budget normally are spent on technology equipment; (b) the funding source is primarily through grants or is tax based; (c) current funding is adequate to switch to a broadband network or upgrade to a faster broadband connection; (d) the budget was cut or increased over last year and the impact of this on technology in the CAI; and (e) the CAI can redirect funding from other institutional expenses to technology if necessary.

Administrative leadership. Adopting broadband depends significantly on the leadership approach taken by the CAI's administration. Administrators must justify costs to boards and other governing bodies as well as to clientele. Sometimes administrators also must convince staff that using new applications and changing current behavior are beneficial actions for the CAI. Possible qualifiers for determining administrative leadership with regard to adopting new broadband-enabled applications include the degree to which the administrator: (a) takes an active role in acquiring new equipment; (b) understands technology's role in the CAI's service provision as important and beneficial; (c) is knowledgeable about possible broadband applications; (d) has the ability to acquire funding for technology; and (e) is willing to allocate funding from other institutional services to technology as needed.

Existence and quality of IT plan. To utilize broadband connections fully requires detailed short- and long-range technology planning. A high-quality IT plan enables a CAI to track past technology policy and equipment decisions and provides a reliable reference for administrators when confronted with contradictory information about services or equipment. Possible qualifiers for determining the quality of a CAI's IT plan include the degree to which an IT plan: (a) is current; (b) includes a detailed budget; (c) includes an inventory of current equipment with the purchase date and a plan for upgrades; (d) includes security procedures and requirements; and (e) includes service quality evaluations of the network.

Administrative and staff interest in new technology applications. As previously stated, an administrator's leadership and ability to persuade governing boards, parent organizations, and clientele are critical factors when considering a CAI's readiness to adopt and utilize broadband. Fundamental for administrative leadership is an interest in finding new technology applications that facilitate new and improved service delivery methods. If the administration is thoroughly satisfied with the status quo, it is unlikely that it would be willing to put forth any significant effort to adopt broadband. Possible qualifiers for evaluating interest in new technology applications from CAI administrations include the degree to which the CAI administration: (a) actively monitors developing applications that might apply to better service provision; (b) encourages staff involvement in professional organizations; (c) encourages collaboration with similar institutions; (d) evaluates current service provision methods; and (e) explores potential cost-saving applications.

Demand from service population. Demand for new and higher-quality services from a CAI's service population is a critical component for justifying any change in service delivery methods or allocation of funding toward new technology. If the service population is uninterested or even hostile to new service applications available through broadband, it is unlikely that a CAI will attempt to change its current service offerings or delivery methods. Possible qualifiers for evaluating demand among the CAI's service population for new technology service applications include the degree to which: (a) the CAI receives feedback from the service population about the need for better or expanded service; (b) problems with service provision are obvious to clientele who report such issues to the CAI; (c) the service population is aware of new technology applications and mentions them to CAI staff; (d) the level of technology adoption among the service population is high; and (e) the service population requests additional services from the CAI.

Community-Based Broadband Planning, Adoption, and Deployment Model

One of the findings from the NFBA and FRBA studies is the need for increased community awareness and community-based broadband planning for these communities to better exploit and leverage their existing high-speed broadband as well as the expanded high-speed broadband that will be available to a greater extent in the near future. This approach focuses first on coordinating CAIs' broadband planning. From the findings, the Institute drafted a preliminary model of Community-Based Broadband Planning, which is depicted in Figure 1 below. The goals of the CBBP are to:

- Increase community awareness of the importance and uses of high-speed broadband;
- Demonstrate specific, high-speed broadband applications such as Health Information Exchanges (HIE) and Health Information Technology (HIT), to CAIs, residents, and decision makers;
- Leverage existing broadband skills and knowledge within communities, especially among key stakeholder groups (which might vary from community to community);
- Encourage CAIs and community residents to subscribe to or upgrade their broadband connections; and
- Develop and implement community-based broadband plans that are updated and revised regularly.

These goals are intended to be, like the model itself, easy to understand and implement in local communites.

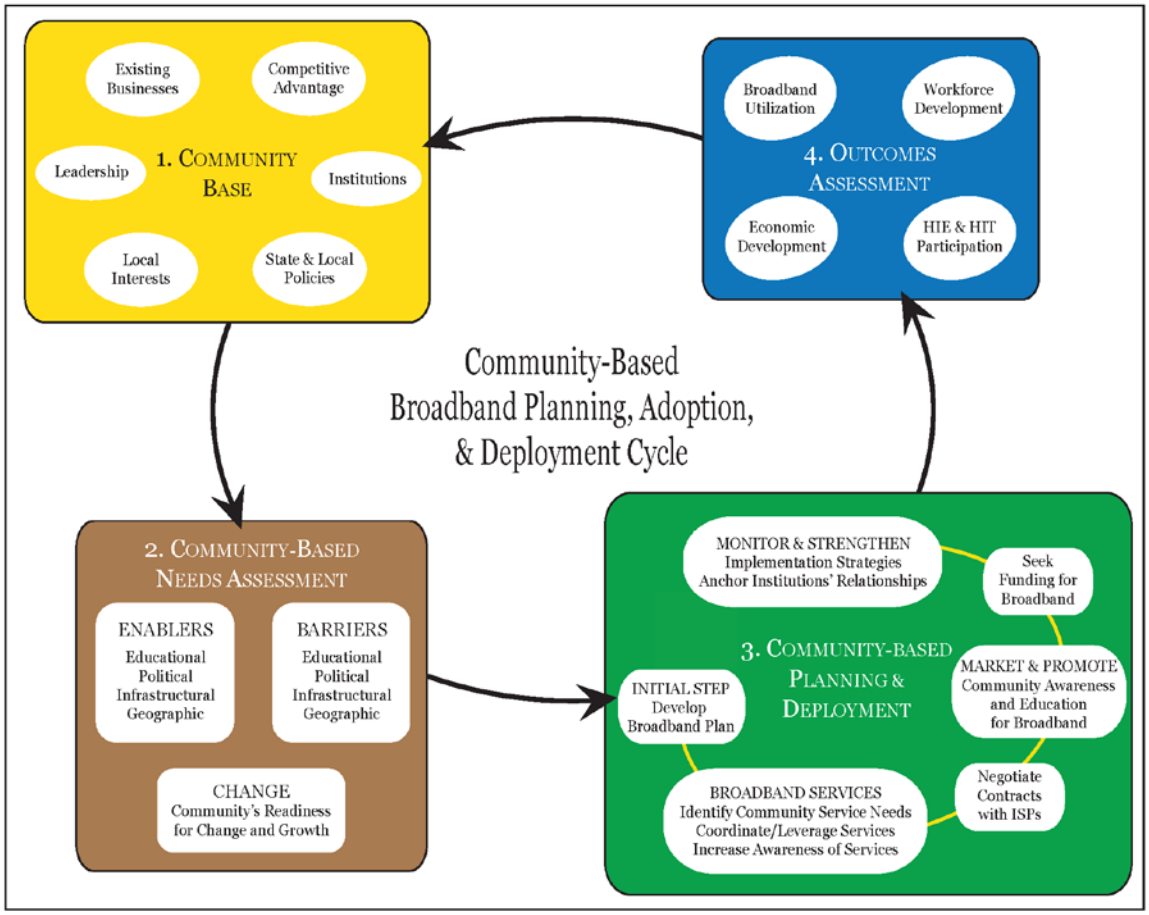


Figure 1. Community-based broadband planning model.

Step 1: Community base. This first step suggests that the planners should identify, review, and describe the resources available in the local community that may affect the broadband planning process. The components comprising step 1 are likely to vary from community to community. For each of these components, the key questions are: (1) what resources are available to support community-based broadband, and (2) what are possible roles for these components in developing the broadband plan. Alemanne, Mandel, and McClure (2011) suggest that in many rural communities, the local public library is recognized as a leader in computer and Internet training, access, and personal assistance and should be considered as a key planning member.

Step 2: Community-based needs assessment. The second step is a process to identify the unique broadband enablers and barriers that exist in each community and then consider the community's

readiness for change and growth related to accessing, deploying, and using broadband. The needs assessment provides a beginning set of data for a community to review and build upon. Community data collection responsibilities should be clearly agreed upon. This step needs to be looking forward to Step 4: Outcomes Assessment, because the first step in assessing outcomes is to benchmark where the community is *before* implementing any intervention (plan, deployment, etc.). Therefore, this needs assessment should include base measures against which the community can measure the changes in attitude, skills, behavior, and knowledge (i.e., outcomes) it anticipates will result from the broadband planning and deployment process.

Step 3: Community-based planning and deployment. The crux of the CBBP process lies within this step. This is where the community develops and begins implementing the broadband plan. Typical components of the broadband plan include:

- Introduction and background;
- Community characteristics and broadband-related needs;
- Goals, objectives, and strategies (these may be related to negotiating with ISPs, coordinating broadband anchor institution services, community education and awareness, publicizing the plan, seeking additional funding to support community deployment and use of broadband, etc.);
- Evaluation process to be used; and
- Process to update the plan.

These components will change based on the various situational factors at work in the community developing the plan. A crucial element is to remember that the plan is not static; rather, it should adapt as the community begins deploying and implementing broadband.

Step 4: Outcomes assessment. This step highlights the importance of outcomes assessment to the broadband planning and deployment process. Outcomes assessment is a process to identify the degree to which an intervention (such as expanded broadband availability) brings change in the community in terms of changes in behaviors, attitudes, skills, or knowledge. The evaluation component of the broadband plan will include the outcomes assessment process and various types of data that will be necessary to conduct this assessment. The topics included in the model are illustrative only of areas where outcomes assessment might occur—actual areas for outcome indicators will vary from community to community depending on the goals, objectives, and strategies in the community's actual plan.

There are a number of potential areas where community-based broadband deployment outcomes might be developed. A *preliminary* list of areas for local impacts and outcomes assessment that the Institute plans to field-test includes the following:

- For residences:
  - Number of ISPs offering broadband connections,
  - Percentage of community residents subscribing to broadband connections,
  - Percentage of community residents who upgraded their existing broadband connections,
  - Change in cost of residential broadband connections,

  - Percentage of residents attending technology training classes or webinars,
  - Percentage of residents engaged in online educational programs and courses,
  - Number of residents (including children) engaged in out-of-school virtual learning, and
  - Awareness of broadband importance, use, and applications;

- For CAIs and other organizations:
  - Revisions or updates in a technology plan specifically related to broadband deployment and use,
  - Percentage of anchor (or other) institutions upgrading their broadband connections,
  - Percentage of anchor (or other) institutions deploying Geographic Information Systems, telemedicine, interactive high-speed video or related "bandwidth-hungry" applications,
  - Number of trained IT professionals per organization,
  - Amount of broadband-related equipment and software purchased,
  - Awareness among organization's IT staff of current broadband applications,
  - Improved desktop connection speeds,
  - Readiness of teachers and school librarians to use broadband in their work,
  - Percentage of instructional activities that use broadband,
  - Existence of or plans for digital textbook and/or one-to-one laptop initiatives,
  - Jobs retained or created that require broadband skills and knowledge,
  - Number of broadband training sessions per organization, and
  - If providing public access workstations or services, degree to which the workstations and services meet clientele broadband needs, or number of public hot spots.

These indicators are illustrative only and will be fine-tuned and operationalized before field testing. Local leaders will tailor combinations of indicators and granularity of data collection to their community's needs. It is important to understand that impacts and outcomes assessment usually takes place *at least* one year after the implementation of the plan, because the idea is to measure changes in behavior that often cannot be measured immediately. The community then incorporates results from the impacts and outcomes assessment into the next planning cycle and development of an updated plan.

These (or other) indicators need to be measured systematically to determine the degree to which they are achieved. Perhaps most significantly, many of these indicators do not immediately register as "new jobs" or "additional revenue," even though those are the impacts expected by many advocates for additional and better broadband services. Rather, changes in skills, attitudes, knowledge, behaviors, and organizational productivity and comprehension of new possibilities and altered ways of doing business will take time to root within institutions and, in the longer term, result in various positive economic and social outcomes. Some of those outcomes may not be able to be anticipated before broadband deployment and use.

Summary of Broadband Indicators

This article proposes two approaches to address the problems related to community-based broadband measurement, adoption, and deployment: one approach is a Broadband Readiness Index that measures community anchor institutions' readiness to adopt broadband, and the other is a Community-Based Broadband Planning model that includes the development of community-based broadband impacts and outcomes measures. The measures proposed in both the BRI and CBBP are intended to be practical, easy to compute and use, comparable across different communities, as unobtrusive as possible, and understandable to local decision makers.

While the BRI and CBBP have yet to be field-tested, they suggest the application of a group of broadband indicators or measures that community leaders can recognize to assess broadband readiness and monitor broadband deployment, applications, and use in their respective communities. Indicators of broadband deployment include broadband coverage data, broadband network infrastructure, government policies, and affordability. Indicators of broadband adoption and use in local communities include accessibility to the Internet, socioeconomic development, and educational achievement. Finally, indicators of broadband applications include the availability of numerous service options; trends in use of e-government services, telemedicine, distance learning, and other broadband-enabled applications; and impacts on the community.

Many possible metrics exist for measuring the impacts and outcomes of broadband, so "a single model is unlikely to reveal all that should be explained about the impacts of broadband" (Holt & Jamison, 2009, p. 580). Although the indicators proposed here may not be all-inclusive or measurable on a statewide or national level, they are applicable, reliable, and measureable indicators of broadband adoption in *communities*. It is important to recognize that local community leaders need indicators they can use at the local level to begin making sense of the confusion currently associated with broadband measurement. The FRBA and NFBA findings suggest that it is better to have some usable measures and strategies and use them to make decisions than to have no measures or bad measures.

Next Steps

The Institute will proceed with the field test of key components that resulted from the original studies as discussed above: the BRI, the CBBP, and selected community-based impacts and outcomes measures. The following research questions will direct the field test:

- How can the nine criteria that currently comprise the BRI be refined, expanded, and operationalized for more practical use at the local level?
- How can the components and steps proposed as part of the CBBP best accommodate the needs for local communities' broadband deployment and use?
- What are the most useful community broadband impacts and outcomes to measure a community's success in broadband deployment and use, and how can these measures be operationalized for easiest implementation in communities?

- What community-based situational factors are barriers and enablers to broadband deployment and use, and how can the barriers be minimized and the enablers maximized in light of communities' situational contexts?

Ultimately, the purpose of the field test is to assist local communities to better exploit existing and future broadband for increasing community residents' quality of life, CAIs' and other institutions' productivity, and communities' economic development.

As this article is being written, the Institute is in contact with a number of counties and communities in the state of Florida to participate in the field test. Communities that participated in the earlier FRBA and NFBA studies likely will be the participants because the study team already has established a track record of credibility in working with them. Communities that participate in the field test will be selected in terms of the degree to which they meet these initial criteria:

- Presence of CAIs with administrations and staff knowledgeable about broadband and interested in participating;
- Presence of local government officials and key residents knowledgeable about broadband and interested in participating;
- Availability of the local public library staff for participating and allowing meeting rooms to be used for planning team meetings, training, and for other purposes; and
- Presence of at least two ISPs in the community.

Other criteria may be developed for communities' participation once the Institute begins discussions with potential participants.

The Institute anticipates that the field test will occur over an 18-month period, as the field test requires adequate time to judge the usefulness of the readiness criteria, measure impacts and outcomes resulting from the development of a community-based broadband plan, and consider situational factors affecting broadband deployment and use in the communities. Products that will result from the field test include an interactive web-based guide for community-based broadband planning that includes a range of self-assessment forms, instructional modules, and other tools such as tips in negotiating broadband service contracts from ISPs. The Institute will make the various products widely available so that other communities can employ them for improved broadband deployment and use.

Conclusion

Because of the many factors that contribute to broadband measurement confusion, such as different speed tests using different methodologies, fixed versus wireless broadband, ISPs providing different levels of services in the same communities, varying levels of data granularity, and even users' computer capabilities, many community leaders have a difficult time clearly articulating their current or future broadband needs. This is made even more complex when CAIs and local officials are unaware of all

the issues confounding broadband measurement. If they are not aware of available broadband options and misunderstand their communities' broadband needs, the communities they represent may have subpar broadband that will not meet their needs or assist them in planning for the future. These issues become critical when one considers that hospitals and police, for example, need real-time, high-speed broadband to care for and protect the citizens in their communities. Community leaders must be able to determine the readiness of key CAIs and other community organizations to exploit broadband and know how to plan for high-quality broadband services.

While researchers may argue about which deployment or measurement framework is best at the local level or which measures are most appropriate and best for national reporting, local community leaders and other decision makers need reliable tools for making informed decisions about broadband in their communities. In short, there is likely to be a need for multiple indicators of multiple types of broadband needs and applications. For example, communities' socioeconomic and educational achievements can be indicators of broadband deployment when measured in communities that lack broadband or when measured after broadband has been deployed.

This paper builds on the overall conclusion from the NFBA and FRBA studies that the lack of standardized measurements and indicators for a number of key broadband activities results in contradictory, complicated, and erroneous information, especially for practical use by local decision makers. Without accurate community-based deployment and measurement information, it will be quite difficult to justify costs and applications or show the impact that high-speed broadband has on a community's health, education, economy, and overall quality of life. This article also extends current research and can inform academic research on melding institutional context and situational variables in analyzing communities' broadband adoption gaps. Approaches such as those suggested above will make it possible to articulate the differences that broadband has made or how broadband deployment and use may be improved in the future.

The Institute's focus is not broadband measurement for measurement's sake; it is to help local communities understand how to measure broadband deployment and use to make informed decisions with regard to broadband adoption, deployment, and use. The use of such strategies is absolutely essential if local communities are to be able to measure broadband adoption, deployment, and use now and to determine how successful they will be in deploying and utilizing broadband in the future.

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