Final Report

Commonwealth's Broadband Roundtable

Presented to:

Governor Timothy M. Kaine

September 9, 2008
Williamsburg, Virginia

COMMONWEALTH of VIRGINIA

Office of the Governor

September 9, 2008

The Honorable Timothy M. Kaine
Governor, Commonwealth of Virginia
1111 E. Broad Street, 3rd Floor
Richmond, VA 23219

Dear Governor Kaine:

On behalf of all the members of the Commonwealth Broadband Roundtable, we are pleased to present this final report and an online toolkit designed to spur local and regional action to address your goal of providing universal access to broadband services for Virginia businesses by 2010.

Since June, 2007, the Roundtable has been diligently working through subcommittees to research and gather information on a variety of topics, including Broadband Adoption Measurement, Broadband Technologies, Innovative Applications, Business Models, and Community Outreach.

In order to provide a readily accessible, easy-to-use product, we published an online "toolkit" that features information on broadband-dependent applications, the characteristics of current and emerging technologies worthy of investment, and case studies from localities across the Commonwealth that have successfully implemented broadband deployment in their communities.

With the help of the members of the Roundtable and others, we have also made great strides in mapping current broadband availability in the Commonwealth, and now have a more comprehensive map of availability for existing businesses, economic development prospects and homes across the state. We are hopeful that these materials will provide the assistance many localities need as they make decisions and work to deploy broadband in their communities. We will continue to market this free toolkit across the state to make local decision-makers aware of this important information.

As co-chairs of the Broadband Roundtable, we would like to thank you for your leadership on this very important topic, and we look forward to continuing to work with you as we strive to provide affordable access to broadband to all of the businesses and citizens of the Commonwealth.

Sincerely,

Mark R. Warner

Aneesh P. Chopra

Acknowledgements

In addition to all of the members who have given generously of their time and talents, Roundtable staff would like to extend their gratitude to the following individuals and organizations for their invaluable contributions:

Broadband Work Group Chairs and Legislative Advisors:

Broadband Adoption
Co-chairs, Michael Powell, Tekedra Jefferson
Legislative Advisors, Congressman Rob Wittman and State Senator Richard Stuart

Broadband Applications
Co-Chairs, Nancy Cooley, Jeff Reed
Legislative Advisor, Delegate Jim Scott

Broadband Business Models
Co-chairs, Ron Carlee, Robin Sullenberger
Legislative Advisor, Senator Phillip Puckett

Outreach
Co-chairs, Sandie Terry, Heather Gold, Bert Schmidt

Technology
Co-chairs, Bob Kahn, Raj Singh
Legislative Advisor, Joe May

Ted Rappaport, University of Texas – Austin; Lem Stewart, Steve Marzolf and Dan Widener, VITA; Virginia Telecommunications Industry Association; Virginia Cable Telecommunications Association; The Center for Rural Virginia; Southern Virginia Higher Education Center and the Southern Virginia Education Network; John Mehfoud, Virginia Economic Development Partnership; The staff of Virginia Interactive; Southwestern Virginia Technology Council; The Virginia Tobacco Commission; Virginia Resources Authority, Southwest Virginia Higher Education Center; John Spencer, Appomattox; Bryan David, Region 2000; Virginia Association of Counties and Virginia Municipal League; and the members and staff of the Joint Commission on Technology and Science.

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Roundtable Membership

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Aneesh Chopra, Virginia Secretary of Technology, Co-Chair

Gary Allen, Virginia Department of Transportation
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Scott Bashore, Loudoun County
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Ali Tabassi, Sprint
Sandie Terry, Franklin County
Tom Trobridge, City of Alexandria
Richard Stuart, Senator, Montross (28th District)
Robert Woltz, Verizon-Virginia

Roundtable Activities

Since its inception in September 2007, the Broadband Roundtable members have traversed the Commonwealth meeting with local and regional leaders and collecting information about ongoing and emerging broadband activities and documenting community needs and barriers to the deployment process.

Roundtable meetings were held across the Commonwealth – Chantilly, Eastern Shore, Richmond, Abingdon, South Boston, and Appomattox. At each meeting, members were briefed on broadband activities in the area and received input from local leaders and private citizens on the deployment challenges and opportunities that remain.

During these sessions it became abundantly clear that community leaders (local and regional) continue to search for assistance with making informed decisions regarding broadband technologies, funding and legal options, and sustainability. To answer this need, members of the Broadband Roundtable determined that the Commonwealth would be best served by the creation of an online "toolkit" for community-led broadband initiatives to de-mystify the broadband decision making and deployment process. Drawing upon the strength of its members, the group has produced an online, interactive toolkit and resources that address not only technology and legal issues, but also assist in the identification of broadband funding sources and often overlooked pockets of "government influenced' funding that can be leveraged to reduce the community capital outlay. The toolkit is available at www.otpba.vi.virginia.gov.

In addition, the Roundtable formed work groups to focus on specific elements of the broadband equation – measurement (adoption and availability), technology, applications, business models, and outreach. The charge to each work group was to examine the challenges and opportunities associated with the broadband planning and deployment process as it related to their individual focus area and to develop creative resources, strategies, projects, and/or policy initiatives that, if brought to fruition, would ease the economic and/or human capital requirements of a broadband deployment.

During the course of the year, the workgroups collaborated to publish an impressive compendium of topic-specific resources, initiatives, and recommendations that will provide the basis for future broadband initiatives in the Commonwealth.

Report in Brief

Observation #1: Growing sentiment in the Commonwealth that universal access to affordable broadband is a prerequisite for economic growth, educational excellence, healthcare reform, and job creation; crux of concern is the growing geographically imposed digital divide as many rural communities continue to lack access to affordable broadband infrastructure

Observation #2: Despite $BNs of private sector broadband infrastructure investment in the Commonwealth over the past decade, myriad communities rely on public investment to address coverage gaps; Virginia's Tobacco Commission leads the way in taking responsibility for $85+M invested to deploy 1,600+ miles of fiber-optic backbone across communities in the Southside and Southwest regions of the Commonwealth

Observation #3: Public sector initiatives deliver results as nearly every major industrial park in the Commonwealth is now broadband accessible (all but 15); that said, local administrators continue to cite concerns by small and/or home-based businesses lacking affordable, reliable access

Observation #4: Governor Kaine seeks to address remaining (un-served) business sites by calling for universal business access to broadband services by 2010 in his Economic Development Strategic Plan; biggest challenge remaining the "last-mile" problem connecting small and home-based businesses to broadband

Observation #5: At the heart of the matter is the assumption that capital investment required to serve geographically dispersed communities exceeds the likely private market returns on the sale of broadband access; by any account, strategies to improve private sector return on capital investment can stimulate market solutions to close coverage gaps

Observation #6: Contending with coverage gaps largely a matter of balancing public policy with private sector investment; though federal and state policy makers can contribute to a solution, local and often regional leaders sit at the center of decisions capable of enticing broadband service providers

Observation #7: A baseline requirement is to have a clear picture of coverage gaps based on address-level data reported at the county level; right approach is to develop market-friendly reporting mechanisms to accurately identify underserved communities that deserve public sector investment priority

Observation #8: Virginia's public policy framework (largely) sufficient to facilitate broadband coverage in underserved communities; key challenge for local and regional leaders is access to implementation support that can assist in structuring a "deal" to attract available public sector capital, stimulate application investments and expedite decision-making

Observation #9: Broadband Roundtable convened to develop a "toolkit" capable of assisting communities with broadband planning and deployment decisions; key deliverables include mapping of broadband service in excess of 768 kbps, an inventory of public-related applications capable of stimulating demand, a user-friendly technology matrix to simplify platform decisions, and an online work-sheet that inventories public and private investment options to expedite last-mile service delivery

Observation #10: While Roundtable's formal work is ending, key priority remains to empower local and regional leaders through the use of the toolkit; Kaine Administration to sustain public policy attention on broadband coverage through codified Office of Telework Promotion and Broadband Assistance

Introduction and Accomplishments

On June 13, 2007, Governor Kaine tasked former Governor Mark Warner and Technology Secretary Aneesh Chopra to lead a broad group of stakeholders, a Broadband Roundtable, to advance his goal of providing universal access to broadband services for all Virginia businesses by 2010. This initiative is a key component of the Governor's Economic Development Strategic Plan released in September, 2006 and furthered by the signing of Executive Order 35 to create the office of Telework Promotion and Broadband Assistance, also in September, 2006.

Why is broadband such a priority? High speed telecommunications services are essential to economic growth and can dramatically increase civic participation, health care access, education, job training, public safety and other needed services. Despite a $300+ million investment in Virginia's infrastructure for broadband services since 1998 (primarily through the FCC's "E-Rate" program and the Virginia Tobacco Indemnification and Community Revitalization Commission), too many Virginians lack access to low-cost broadband services. An analysis of Federal Communications Commission 2006 survey data revealed that less than half of Virginia's households utilize broadband services. More troubling, America continues to slip in global rankings measuring broadband penetration falling to 15th in the December 2006 report issued by the Organization for Economic Co-operation and Development.

A variety of factors – geography, population, laws and regulation – contribute to an environment where the private sector struggles with the business case for additional investment to close these coverage gaps. In general, sparsely populated areas have not attracted the same level of investment and innovation as more dense urban areas.

To address these challenges, Governor Kaine challenged the Broadband Roundtable with the following goal: to provide localities interested in providing (or facilitating the delivery of) broadband access to constituents with a resource to accelerate implementation heretofore referenced as the "blueprint". In addition, the Roundtable was instructed to remain focused on three principles - long-term sustainability, public-private partnership, and community-driven strategy.

Co-Chairs Warner and Chopra established five working groups to address this challenge and are pleased to report considerable progress toward the fulfillment of the mission:

1. ***Broadband Adoption Measurement:*** **A benchmark on current access based on innovative models to measure availability and adoption; goal to identify community gaps.**

   Accomplishments:

   - The Commonwealth now recognizes the "new" FCC definition of at least 768Kbps download speed and at least 200Kbps upload speed as the minimum definition of broadband service.[1]

   - The Commonwealth now has a process in place to collect and map geo-coded address-level broadband availability data and geo-spatial and demographic information displayed at the County level - at no additional cost.

[1] For the purpose of the initial baseline mapping initiative, wireless services providing 200Kbps download speeds were also included.

Broadband Adoption Measurement Accomplishments - continued

- The Virginia Economic Development Partnership now has a baseline (database and map) of broadband accessibility for the more than 4,200 properties (industrial sites marketed by the Commonwealth) in the VAScan database; a modest 15 properties remain to achieve universal access to broadband services for Virginia's marketed industrial parks.

- Communities throughout Virginia will have access to a web-enabled architecture for inventorying/categorizing and mapping vertical infrastructure elements that can be leveraged as part of a broadband planning and deployment process.

2. ***Technology Blueprint:*** **A technical review of existing and emerging technologies (wired and wireless) suitable for delivering affordable services across the Commonwealth; goal to level the knowledge gap between vendors and communities.**

   Accomplishments:
   - Communities pursuing wireless broadband solutions now have public policy support (SB206/HB1329 – 2008) to access space on existing state police towers as a means of reducing capital costs for broadband deployments.

   - The Roundtable has published a technology "matrix" to de-mystify the current and emerging technologies options capable of delivering broadband services in a variety of terrains and socio-economic climates.

3. ***Innovative Applications:*** **A strategic review of broadband-dependent applications including telework, telemedicine, distance learning, public safety interoperability and social empowerment that deliver public benefit; goal to spur community investment**.

   Accomplishments:
   - The Roundtable has published an inventory of applications capable of attracting public sector (or publicly-related) investment to create market demand.

   - The Roundtable has successfully facilitated the development and deployment of broadband-dependent applications such as the Virginia Acute Stroke Telehealth Network (FCC funded project to develop a statewide telestroke network in partnership with University of Virginia, Virginia Department of Health and the Virginia Telehealth Network), the Governor's Telework initiative, and a myriad of public safety/interoperability projects.

4. ***Business Models:*** **A primer on the community models currently operating in the Commonwealth with a focus on recent (favorable) policy changes regarding public-private partnerships and access to VRA financing as a means of lowering public investment necessary to provide access; goal to encourage community utilization of available remedies.**

   Accomplishments:
   - The Roundtable has produced an online "toolkit" to assist localities in developing community-led broadband deployment initiatives to accelerate deployment; community broadband case studies, best practices and associated documents are included as models for other Virginia Communities.

5. ***Community Outreach:*** **A series of "how to" and community case studies highlighting the value of broadband services and the imperative for community leadership; goal to encourage community involvement and drive business and resident adoption.**

   Accomplishments:

   - Office of Telework Promotion and Broadband Assistance created by Executive Order (35) in 2006 and codified in 2008.

Working Group Reports

Broadband Measurement – Availability and Adoption

Documenting broadband availability is a daunting challenge at best. In the post-9/11 security environment, access to data relating to broadband infrastructure (now deemed to be "critical" infrastructure) has become so difficult that many states have conceded the process – citing that it is just too difficult to accomplish without significant investment.

In recent days, the exercise has become even more complicated by a rising debate about exactly "what speed" represents the minimum threshold for a service to be considered "broadband".

Repeatedly, members of the Roundtable were reminded of the critical role mapping data plays in the ability to make strategic broadband planning and investment decisions…a process now driven by anecdotal information and locally collected survey data.

As a result of these conversations, the Roundtable launched a Commonwealth-wide mapping initiative that, if successful, will allow leaders at the state and local levels to readily **identify and focus on un-served areas** and allow policy makers to prioritize and direct resources and investment. The map (as intended) will illustrate broadband service availability from currently deployed technologies—wireless and wireline and, to the fullest extent possible, next-generation (3G/4G) solutions.

At the time of publication, data collection efforts are underway in the Commonwealth under the direction of the Secretary of Technology and leadership of CIT. The exercise is voluntary but is receiving full cooperation and support from private sector providers. CIT has taken great care[2] to safeguard and protect competitive information through non-disclosure agreements and the display of only aggregate (county level) data.

Maps produced through this process will be posted on the CIT-Broadband (http://www.cit.org/programs/broadband.html) and Broadband Roundtable (www.otpba.vi.virginia.gov) websites anticipated for publication before the end of 2008.

[2] Providers sign a Non-Disclosure Agreement with the Center for Innovative Technology (FOIA exempt, non-profit organization) that to provide geo-coded, address level broadband data that will be layered onto geo-spatial and demographic maps produced by the Virginia Information Technology Agency (VITA)

Technology

For community broadband deployments, the overriding objective should be to provide individuals, businesses, and governments with affordable access to whatever technology allows the execution of desired online activities in a timely and cost-effective manner. In most cases, the technology options requested by consumers are not driven by the technology name, but rather by its ability to accommodate the type of applications to be used.

There is no single technology solution that will solve all of the Commonwealth's broadband connectivity concerns. While fiber currently offers the best long term, fastest, and most reliable solution, there are other technologies that can provide reasonably good alternative solutions.

Leaders in un-served communities in Virginia are faced with a long list of questions to answer and options to consider as they navigate the broadband decision making process. One of the most critical (and often most challenging) decisions is "which" technology is most appropriate for the proposed area of coverage. Unfortunately, many communities lack strong technical "in house" expertise capable of balancing the need for a suitable near-term solution, with the requirements of long term sustainability and reasonable return on investment. In some instances, the lack of technical knowledge and a perceived inability to be able to make the "right" choice is sufficient to delay or de-rail the entire deployment process.

In the absence of providing each locality with an experienced broadband deployment consultant to assist with the selection and implementation process, the Roundtable's esteemed technology committee created a technology attribute "matrix" (Appendix One) to provide technology specific information including: bandwidth, capabilities and limitations, appropriate scenarios for use, and general cost estimates to level the playing field and expedite the decision making process.

Applications

Applications (programs, services) are the life-blood of any broadband network. Historically part of the great "chicken and egg" debate about broadband networks (which should come first), applications are now so plentiful, **it is no longer a matter of "whether" a consumer (organization/individual) wants to use a broadband application, but rather "which" application(s) are desired.** The value proposition for someone to acquire a broadband connection is generally rooted in the type of application they desire to use. For planners, understanding the role of applications and selecting a technology (or technologies) capable of accommodating the bandwidth needs of both industrial and individual users is paramount – without adequate bandwidth (current and future), the network will stagnate and once again fall on the wrong side of the broadband "availability and speed" digital divide.

In addition to serving as an "anchor tenant" in the technology investment planning process, large scale applications (first responder interoperability, school connectivity, rural healthcare) can also provide grant funding that can be leveraged for network build-out and sustainability. Often, organizations employing (or desiring to employ) these applications are capable of providing much needed capital and sustainable revenue streams for newly emerging networks.

Recognizing the important role that applications play in the technology selection and business case of community-led broadband deployments, Roundtable members have identified and documented the uses and characteristics of some of the most desirable and frequently leveraged applications that should be considered and courted during the broadband planning process. The list, including applications such as telehealth, digital government, e-commerce, and distance learning is now available on the Roundtable website at www.otpba.vi.virginia.gov.

Business Models - The Role of Leadership

There is no single policy change or initiative that will solve these broadband deployment problems overnight. Therefore, governments and regulatory agencies at all levels must act as enablers, not impediments, to community-led deployments and private investment. In fact, broadband deployments in un-served areas **must** become a top public policy priority with government acting in a leadership role to make ubiquitous affordable broadband a reality.

In Virginia, the Kaine Administration, General Assembly, State Agencies and organizations in concert with local leaders are banding together, aligning existing resources (attempting to create new ones where holes exist) and cooperating with the private sector to facilitate the deployment of last mile broadband services. As the "Mother of Presidents," Virginia is known for creating strong, tenacious and dedicated leaders who understand the imperative and are willing to commit time, energy and scarce resources to insure that all Virginians share in the Commonwealth – in this case, ubiquitous, affordable broadband services.

The most notable example of government commitment to broadband is the investment that the Virginia Tobacco Commission has made in broadband infrastructure for Southside and Southwest Virginia. As of this publication date, the Virginia Tobacco Commission has contributed $85.8M to the construction of more than 1,666 miles of operational "open access" fiber in Southside and Southwest Virginia. The funds also leveraged $12.17M from the U.S. Department of Commerce - Economic Development Agency.

Many broadband initiatives in the Commonwealth are structured as public-private partnerships fueled by Virginia's "broadband friendly" legislative and business environment. While use of these hybrid, public-private models are on the rise, much of the focus and funding remains directed toward building infrastructure instead of cultivating relationships and deploying programs that can ultimately provide a similar outcome, but in a more cost efficient and expedient manner.

What has become apparent through the work of the Roundtable is that despite our best efforts to align resources and policies into a cohesive "package" for communities to leverage, holes remain, leaving leaders in the Commonwealth without a complete "slate" of policies and resources to build upon when crafting a broadband initiative.

Suggested activities to complete the "slate" of broadband resources and eliminate remaining deployment barriers the Commonwealth include:

- **Removing barriers to investment:** Identify and eliminate unnecessary regulation and policies that inhibit or slow private sector investment such as access to rights-of-way, tower site regulation, access to municipally-owned towers and structures, permitting and licensing, and asymmetric regulations (that treat one class of providers differently from another).

- **Leverage existing assets:** Create incentives for state and local governments to allow placement of additional antennae on existing government-owned towers and other structures (e.g. buildings, water towers, etc.). Require that expenditure of public dollars in construction of towers and other broadband related infrastructure consider potential use by private sector providers. Require that state and local agencies coordinate government tower construction to facilitate efficient use of resources.

Suggested activities to complete the "slate" of broadband resources – *continued*

- **Create incentives to investment:** Incentive programs (exemptions, deductions, tax credits, application-centric grant programs) will help attract private infrastructure investment. Priority should be given to un-served areas of the Commonwealth.

- **Work with federal agencies:** Revamp existing loan/grant and incentive programs to increase and prioritize aid into un-served areas.

- **Leverage existing organizations:** Develop low-cost loan and grant programs to augment existing broadband funding mechanisms.

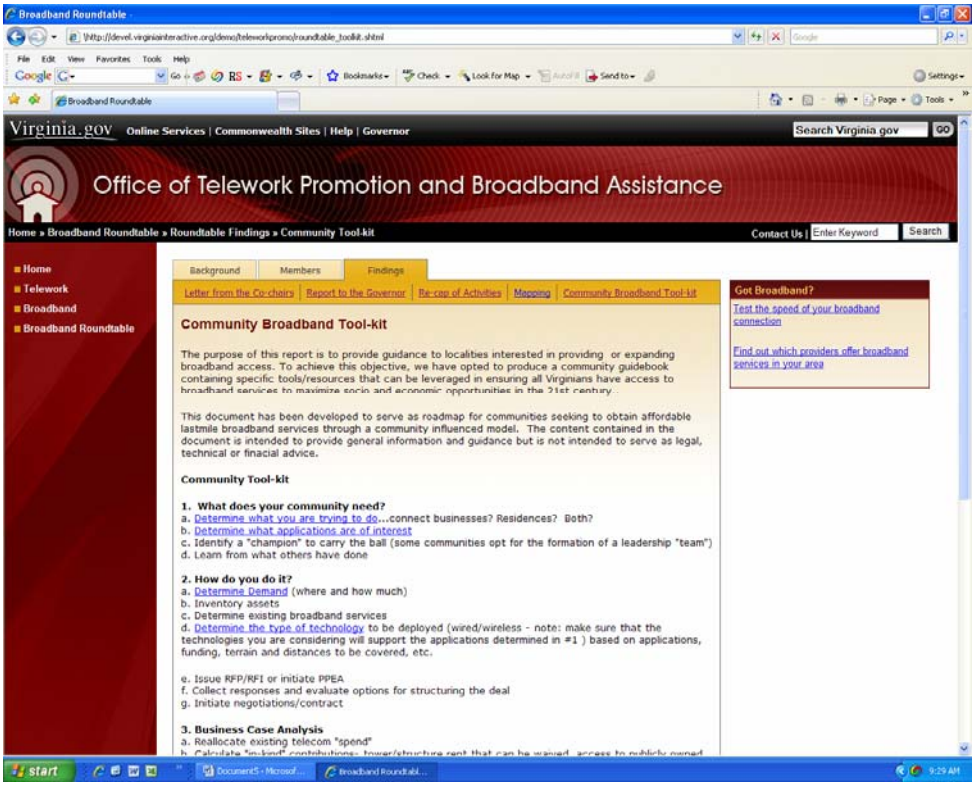
- **Leverage the Commonwealth's Buying Power** by ensuring to the maximum extent possible, all state contracts – existing and future – for telecommunications and broadband services can be leveraged by local governments.

Business Models - Community Tool Kit

In the Commonwealth, many un-served communities have opted to initiate broadband deployments in an attempt to secure their place in the knowledge economy. Some have opted to leverage their municipal electric utilities and become municipal local exchange carriers (MLECs), while others have chosen to form wireless authorities or public-private partnerships. While the technologies utilized vary greatly, the underlying decision making process, (while not always carried out sequentially) generally follows a decision path from beginning with "what" are we trying to do to, deciding "how" to do it, and finally to establishing a plan for "how to pay for it".

Fortunately, communities that have been through the process have been forthcoming with their experiences – good and bad, and have availed that information to the Roundtable for analysis and documentation as case studies. The analysis of these experiences coupled with an examination of the available legal and funding mechanisms has resulted in the creation of a free online Community Broadband Toolkit.

The toolkit (shown below), now available at www.otpba.vi.virginia.gov centers on walking communities through a step-by-step, strategic approach to the broadband planning and deployment process, including a "buy-down" worksheet to help planners calculate the amount of "government influenced" funding and assets that exist in the community.



Outreach

Thanks to the hard work and dedication of Roundtable members, un-served communities in the Commonwealth now have a toolkit of resources and information to leverage when developing a community-led broadband initiative and leaders at all level of Virginia government have a better understanding of the challenges and opportunities that remain.

One of the key elements to overcoming the remaining barriers is consistency of purpose and messaging. It is incumbent on the leadership of the Commonwealth to communicate a solid commitment to ubiquitous affordable broadband access by:

- Strengthening the Commonwealth's focus on broadband: Ensure that state government is properly organized, coordinated and applying the appropriate resources and policies to close Virginia's broadband gap.

- Codifying a "Broadband Deployment Council" comprised of members of the executive and legislative branches along with representatives of private sector broadband providers and consumers. The primary functions of the Council will be to allocate funding, oversee broadband mapping efforts, monitor the status of broadband deployment in the state and recommend broadband policy to the Governor and legislature. Expiration date for this Council should coincide with the accomplishment of providing broadband availability to all citizens or 10 years (the term of the Office of Telework and Broadband Assistance)

- Strengthening the Office of Telework Promotion and Broadband Assistance with additional personnel to educate and provide technical assistance to local governments and communities seeking to expand broadband and applications of broadband technology and to staff the proposed Broadband Deployment Council.

- Conducting educational campaigns to: 1) improve understanding of wired and wireless broadband technologies, (factors that go into tower design and placement) 2) increase use of the PPEA and other public-private partnerships; and 3) encourage use of the online community broadband toolkit.

- Assisting communities with "broadband friendly" ordinances and fast-track permitting policies for construction of all broadband technologies. Where applicable, communities should be encouraged to update their Comprehensive Plan to include telecommunications

In order to provide continuity of messaging and activities going forward, Roundtable staff will continue to work in close coordination with the Office of Telework Promotion and Broadband Assistance, the Center for Innovative Technology, Virginia Resources Authority, Virginia Association of Counties, the Virginia Municipal League, the Center for Rural Virginia, Virginia Tech eCorridors, the Kaine Administration, General Assembly and members of the private sector so that the integrity and value of the work done by the Commonwealth's Broadband Roundtable is perpetuated.

Appendix One: *Technology Attribute Matrix*

Technology	Digital Subscriber Line (DSL) Like Access	Ethernet over Copper 802.3ah	Fiber-to-the-Premise (FTTP) Passive Optical Network (PON)	Wireless 3G	WiMAX	WiFi	Satellite	Broadband over Powerline	Hybrid Fiber Coax - Fiber to the Node, then Coax to the premise	Fixed Wireless
Short Description	Copper wire run or wireless from DSLAM/Fiber Node for distribution in home or office	Multiple copper pairs (up to 8 pairs) bonded to deliver up to 45Mbps from CO aggregation device for distribution to office	Fiber optic connections directly from a Network access point to a residence or business	Mobile and Fixed Wireless WAN	Fixed and mobile wireless provided by WISP through WiMax	Fixed wireless provided by WISP on unlicensed spectrum through WIFI	End user installs a satellite dish for two way broadband connection	Use of commercial power line infrastructure to deliver broadband	Fiber optic backbone to a local Node (neighborhood) and Coaxial copper to the home	Fixed wireless provided by ISP using unlicensed frequency bands (NON-WIFI).
End User Data Rates									DOCSIS 2.0	
Dowlink Residential	768 kbps	Up to 45Mbps	100 Mbps	4 Mbps	4 Mbps	2.5 Mbps	2.0 Mbps	1.0 Mbps	5.0-15.0 Mbps	500k to 3Mbps
Uplink Residential	200 kbps	Up to 45Mbps	100 Mbps	1 Mbps	2 Mbps	500 kbps	768 kbps	100 kbps	2.0 Mbps	500k to 3Mbps
Downlink Business	5. 0 Mbps	Up to 45Mbps	2.4 Gbps	4 Mbps	10 Mbps	10 Mbps	8-10 Mbps	5 Mbps	6.0-30.0 Mbps	5Mbps to 15Mbps
Uplink Business	2.5 Mbps	Up to 45Mbps	1.2 Gbps	1 Mbps	2.5 Mbps	2.5 Mbps	2 Mbps	2.5 Mbps	3.0-5.0 Mbps	5Mbps to 15Mbps
Usage										
Voice and/or Data	Voice/DATA	Voice/DATA/Video	Voice/Data/Video	Voice/DATA	DATA	DATA	DATA	DATA	DATA, Voice, Video	Data, Voice, Video
Range of Coverage from edge of Infrastructure	500 ft. to 2 miles from hub	20 kft w/o repeater, variable up to 40 kft w/repeater	12 miles from Point-of-Presence	2 -5 miles from serving tower	2 -5 miles from serving tower	1/2 mile from access point	200 ft. from satellite dish	500 ft. from amplifier	< 3.3 miles from Fiber Node	< 5 miles from access point
Availability	Now	Now	Now	Now & EvoMing	Emerging	Now	Now	Emerging	Now	Now
Reliability	Medium	High	High	High	Medium	Medium	High (99.7%)	Low	Medium	High
Quality	Medium to High	High	High	High	High	Medium	Medium to High	Low	High	High
Can end user install completely by themselves?	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Initial End User Setup Time	1 Hour	1 Hour	1 Hour	1 Hour	1 Hour	1 Hour	3 Hours	1 Hour	1 Hour	2 hours
Degree of Mobility	High when neighborhood Wireless Coverage, Low when using copper to the home and WIFI	Low - Fixed Location Access Technology	High when using HPNA, or wireless router. Low, when using WIFI in home	High	High	Medium (Portability)	Low, when using WIFI in home	Low, when using WIFI in home	Low (can use WIFI in the home)	Low. Antenna attached to facility. Wifi can be used within the premises
Round trip Latency	Approx. 30 ms	Approx. 30 ms	Approx 1 ms	Approx. 30 ms	Approx. 45 ms	Approx. 60 ms	Approx. 500 ms	Approx. 100 ms	Approx. 10 ms	Approximately 45ms
Security Issues	Firewalls supported	Firewalls Supported	Firewalls supported	Built-in Encryption	Built-in Encryption	Built-in Encryption	Built-in Encryption	Firewalls supported	Firewalls supported	Built in Encryption
End User Device Installation Issues	Small ~ Some Tech Skills Required	Small ~ Some Tech Skills Required	Small ~ Some Tech Skills Required	Easy self install	Easy self install	Easy self install	Trained technician required to install	Many devices are currently commercially available. Must have access to phone jack and power.	Small ~ Some Tech Skills Required	Trained Technician Installation
Envrionmental Factors										
Most sensible end-user density requirement (homes per square km)	Low density housing is acceptable for pure DSL solution. Sufficient end users required to justify expense of Fiber to the neighborhood.	Low density business dispersion is acceptable for EoCu deployment based on low to medium start-up/infrastructure costs.	High to medium density such as urban core, high rise buildings required to make economic sense	Supports all housing densities. Economically efficient by leveraging existing mobile voice networks	Low Density Housing acceptable. Requires large enough market in a 2-3 mile radius to justify expense of backhaul and serving tower	Low Density Housing acceptable. Requires large enough market in service radius to justify expense of backhaul and serving tower	Very Low Density Housing makes most sense for Satellite	Low Desnity Housing acceptable. Requires sufficient market near major power line stations	Moderate to High Density. Sufficient end users required to justify Fiber build to area.	Low cost of infrastructure and no licensing expense means lower density required. 5 customers per sq. mile is adequate with 10 per sq/mi and higher optimal
Type of Terrain required, and issues with local topography	Works in all kinds of terrain, except for solid rock where trench cannot be dug economically	On average, at least 8 copper pairs are available to most businesses. Technology works over existing copper pairs used for legacy telephone lines and T1 services. UNE-L loops are widely available from ILECs for $9-$12 per pair	Works in all kinds of terrain. Fiber may be installed overhead in rocky conditions and underground where conditions allow, economically.	Works in all kinds of terrain. Does NOT require line of sight	Requires Line of Sight or Near Line of Sight from serving towers to end users. Growth of Foliage or surrounding mountains can impair quality	Requires Line of Sight or Near Line of Sight from serving towers to end users. Growth of Foliage or surrounding mountains can impair quality	Requires Line of sight to the sky, and proper siting of satellite dish. Growth of Foliage or surrounding mountains can impair quality	Works in all kinds of terrain, often uses above-ground electric utility pole wiring to end user	Works in all kinds of terrain; for solid rock economical trench would need to be provided	Non-line of sight capabilities but will not penetrate earth or rock. Service can overcome dense foliage but range is reduced.
Covenents, Licenses, or Right of Way Issues	Few if any. Uses existing copper wiring, and telephone easements are part of normal real estate transactions	Few if any. Uses existing copper wiring, and telephone easements are part of normal real estate transactions	Requires new installation of fiber infrastructure. Use of existing utility, VDOT and municipal R/W and franchises. No outdated copper used.	Few if any for existing voice, or voice & data, network upgrades	Wireless will require approval of tower location by local ordinance. Homes may require zoning approval for antennas. Copper has few if any issues.	Wireless will require approval of tower location by local ordinance. Homes may require zoning approval for antennas. Copper has few if any issues.	Few if any. Satellite operators have nationwide license	Equipment may be suseptible to complains by amateur radio operators due to interference by some BPL devices	Few if any. Uses existing utility rights of way, and cable easements are part of normal real estate transactions	Wireless will require approval of tower by local ordinances or colocation on existing structures.
Required Proximity to DSLAM or Broadband Pipe	Needs to be within 2 miles of a DSLAM	Needs to be within 2.5 miles of a CO aggregation device, repeaters can extend that distance	12 miles from Point-of-Presence	Needs to be within 3 - 5 miles of serving tower	Needs to be within 3 - 5 miles of serving tower	1/2 mile from access point	No requirement	Within 1 mile of Amplifier	Hub site to Fiber Node < 25 miles, < 3.3 miles coax from Node	Customer premises needs to be within coverage pattern from nearby tower
Sensitivity to Weather	None	None	None	None	Minor	Minor	Yes	None	None	Minor
Cost Of System Deployment										
End User Component costs	Low, mass market pricing ($30)	Competitive for High Performance Business Services ($500-$2,000)	High, abundantavailability of product. Material and labor cost below $600. Equipment not installed until customer signs up.	Medium, price points coming down ($100)	Medium, price points coming down ($150)	Medium, price points coming down ($30 - 40)	High, requires antennas, electronics, cables ($200)	Medium to low cost ($100)	Low, mass market pricing ($30)	High. Requires antenna, technician, and wireless modem.
Infrastructure Costs	Low, uses existing POTS wiring	Low, uses existing POTS wiring	Higher than wireless, but less than copper.	Low	Low	Low	High, requires satellite launch, tracking stations	Medium, requires circuity at power stations across power grid	Medium	Low. Tower infrastructure is inexpensive relative to satellite or fiber
Maintenance/Repair Costs of Infrastructure	High	High	Moderate	Low	Low	Low	Low	Low	Medium	Low
Interoperability	Can interoperate; standards based	Can interoperate; standards based	Can interoperate; standards based	Can interoperate; standards based	Can interoperate; standards based	Can interoperate; standards based	Can interoperate; standards based	??	Can interoperate; standards based	Can interoperate. Standards based.
Standardized for multiple equipment/carrier interaction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	??	Yes	Yes.
Technical Issues										
Limitations	Must have access to phone jack and power	Must have access to copper pairs and power	Must have access to electrical power. 12 hour battery back-up is provided.	Range	Range	Range	Must have clear shot of sky for desired satellite. Installed close to home	Must have access to phone jack and power	Must have access to coaxial outlet and power	Range and tower structure availability
IP Address Assignment	Layer 3	EoCu is Layer 2, interoperates with Layer 3 devices for routing and security	Layer 3	Layer 3	Layer 3	Layer 3	Can support external or private IP address assignment.	Can support external or private IP address assignment.	Layer 3	Layer-3