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September 19, 2014

Hon. Fred Upton
Chairman
Energy and Commerce Committee
US House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Hon. Greg Walden
Chairman
Communications and Technology Subcommittee
Energy and Commerce Committee
US House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Re: Communications Act Update; Universal Service

Dear Representatives Upton and Walden:

Thank you for the opportunity to comment on universal service as part of your effort to update the Communications Act. You provided a thoughtful white paper on the concept of universal service and asked some valuable questions on how to address the issue going forward, something especially important as the US has transitioned from the paradigm of fixed line telephony to digital internet protocol.

In the re-released book *Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System*, internet governance scholar Milton Mueller expertly documents that universal service meant something else when it was first implemented in the early 20th century. Indeed universal service was about interconnection, not a phone in every home. “Contrary to the prevailing mythology, it was that period of systems competition (1894-1912), not the ensuing period of regulated monopoly, which gave birth to both universal service as a policy prescription and the physical reality of a geographically ubiquitous telephone infrastructure. Moreover, the refusal of Bell and the independents to interconnect with each other actually promoted the rapid geographical extension of the network.” notes Mueller. As such, it is important to re-examine the meaning of universal service as Americans has largely jettisoned traditional telephones.

My one recommendation on universal service is to think of it not in terms in networks, but in terms of “services and applications”. There are many broadband networks in the US today—cable, DSL, fiber to the premises, 4G/TLE, satellite, wifi etc. Creating universal service commitments for each network would be unwieldy and inefficient. Instead Congress should focus on ensuring that key digital services for public safety, health, education, employment, egovernment and so on are designed to be consumed on low bandwidths. This will increase the likelihood of availability of essential services on any kind of broadband network, whatever it may be.

Moreover, given the existing footprint of DSL through copper networks enabled by universal service to date, the focus on applications and services available at low speeds will improve the likelihood that all citizens have access to essential services at low costs.

My colleague Justin (Gus) Hurwitz of the University of Nebraska Law School and I have elaborated on this notion in our recent paper “Debatable Premises in Telecom Policy”. We presented this paper at the Telecommunications Policy Research Conference earlier this month. The relevant section of the paper is attached, and the full paper can be accessed at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2418733

Your whitepaper also indicates the abuse of the Low-Income program for free cellphones and service. It is an unfortunate state for taxpayers who by law must pay their communications bills, only to discover that their money has been squandered. Congress is wise to build future programs such that incentives for abuse are eliminated.

It is well documented that the United States has some of the lowest prices in the world for entry level broadband and mobile wireless access. My recent paper on broadband in the US discusses the data from both the OECD and the ITU.[1] For example the ITU notes that connectivity should cost no more than 5 percent of income. Basic communications services in the US can be purchased for less than 1 percent of income. To the extent that services and applications can run on low bandwidths, Americans can purchase communications services outright without having subsidies.

Moreover Americans spend far more of their income on housing, energy, education, transportation, food, clothing, and even discretionary vacations than they do on telecommunications. If Congress is interested in helping low-income Americans, it should focus on these areas which take up a greater percentage and amount of income.

It is worth mentioning that designing applications and innovations to run on low bandwidth is an important incentive and opportunity for innovation. Rather than making subsidies, Congress can provide prizes and rewards for the best innovations.

Thank you for the opportunity to comment.

Sincerely,

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[1] Michael Horney and Roslyn Layton, *Innovation, Investment and Competition in Broadband and the Impact on America's Digital Economy* (Mercatus Center at George Mason University, August 15, 2014), http://mercatus.org/sites/default/files/Layton-Competitionin-Broadband.pdf.

Excerpt from *Debatable Premises in Telecom Policy* by Gus Hurwitz and Roslyn Layton

Debates over telecom policy are necessary to the wellbeing and prosperity of our country. Sound telecom policy can benefit consumers nationwide; bad ideas can be terribly costly. At its best, telecom policy can help lift the poorest and least fortunate among us to prosperity, afford unparalleled access to education, health, and other essential services, and create platforms for expression and enterprise unknown at any prior point in human history. Few, if any, other technologies or industries have the potential to create so much good for so many.

As a result, these arguments tap into deep currents in the popular psyche. The questions at issue in telecommunications policy reflect values at the core of our democracy, social commitments to equality and universal access, and concern over censorship and centralized control of information. The intuitive appeal of these arguments ensures that they find substantial support among well-intentioned legislators, regulators, and much of the public. But intuitive appeal often leads analysis astray. This paper relies primarily on economic and technical analysis and research to demonstrate that the intuitive approach to these issues often leads to conclusions deleterious to consumers.

That the consumer must come first is a central theme that runs throughout this analysis, and should be a guiding principle through all telecom policy debates. It is too often the case that even well-intentioned and seemingly consumer-friendly policies do not fully appreciate the complexity of the market and therefore fail to place the interest of all consumers ahead of the interests of specific, often narrow, interest groups.

Hopefully, identifying faults in these premises will help us to address the issues that they represent with greater care; and hopefully this paper's presentation will foster discussion about the role of economically- and technically-informed research in policy debates. This is an exciting time in telecom policy. It is also a challenging time, given the fundamental shifts in technology and the industry that have occurred in recent decades.

This paper proceeds in six parts. Each of the first five parts corresponds to one of the premises listed above. Part six discusses themes that run through several of these premises and considers the role of substantive telecommunications research in telecommunications policy debates.

I. Premise One: Everyone Needs Low-Cost Access to High-Speed Broadband

The first premise considered is that everyone needs low-cost access to high-speed broadband. This idea is central to contemporary debates in the telecom space and guides much of current policy. This premise gives rise to several related policy prescriptions: ensuring the availability of service everywhere (universal service); ensuring that service is either low-cost or subsidized for those who may not be able to afford access; ensuring that at least one carrier offering such service is available to every consumer (a "carrier of last resort"); and imposing various service-level guarantees and quality of service requirements on every carrier.

As an initial matter, universal telephone service has historically been leveraged to support various important social commitments. Ensuring that everyone has access to some basic communications platform, so that they are able to get access to emergency services and avail themselves of other important government and social programs is an important value that we should strive to maintain. As will be repeated several times in this paper, the consumer must come first – it is unquestionably the case that there is a set of basic services that we should ensure are available to all consumers.[2]

The challenging questions are at what level and by what means do we maintain these commitments. Many in the telecom policy space – often those with the loudest voices – have long advocated that every American needs access to high-performance telecommunications services (today, that is high-speed Internet service) at low cost. Indeed, a majority of what the FCC does today is done with this goal, directly or indirectly, in mind. But while there is a strong argument that we should endeavor to provide every American with access to some level of connectivity, it is unclear what that level of connectivity should be. Indeed, as we have transitioned from narrowband voice communications to broadband Internet connectivity, the advocates and policy makers have consistently increased their target for sufficient levels of connectivity. Importantly, these changes have tracked changes in median (or even high-end) usage patterns, as opposed to tracking what is sufficient to provision socially necessary services.

Historically, the difficulty of determining what services belong in this set has been masked by the nature of telephone technology. The basic unit of connection – the twisted pair of copper wires – that was necessary for any service was also sufficient for most services of interest to most consumers. As a result, by requiring universal provision of the most basic services, we also facilitated the provision of more advanced services.

This no longer holds in today's digital economy. One can get connected to the communications network through various means: fiber, coaxial cable, wireless voice, fixed and mobile wireless data, satellite, and even still, the good old twisted pairs of copper. Each of these means of connecting to the network offers better or worse support for various services and applications. Fiber is very fast but expensive; cable and (especially) DSL are somewhat slower, but are also somewhat cheaper; wireless is generally a bit slower still (at least as of today), a bit less reliable and often somewhat more expensive than cable – but it's mobile, which is pretty great! Some of these technologies are better for voice service, for video service, for downloading large amounts of data, or for playing video games. Some of these services are also better or worse regarding our social commitments: mobile wireless, for instance, is great in that you can bring your connection to emergency services wherever you go; but it is problematic that it can be difficult for those emergency services to know your location should you need them to find you.

Developments in the many technologies suggest that we need to take a more nuanced view of how to provision communications networks to support important social commitments. The historical precedent, that we would provision a connection capable of supporting nearly the full range of possible services, was a happy historical accident. It was possible in part because the basic unit of service was capable of supporting the full range of consumer-oriented communications services. And it was possible in part because the relative elasticities of demand for communications services offered a relatively efficient mechanism for funding universal service buildout.[3]

The most difficult aspect of this more nuanced view is that we need to think seriously about what services are included in the bundle of basic social commitments.[4] Many advocates argue that every American should have

[2] *See, e.g.,* Chairman Wheeler's Network Compact.

[3] Cite discussing Ramsey pricing and how relative elasticities of demand for these services have changed over time (e.g., cross-subsidizing residential loops from business long distance is relatively more efficient than cross-subsidizing (inelastic) low-speed broadband from (elastic) high-speed broadband).

[4] Another aspect of this is the relative lack of appreciation for the relative scale of bandwidth requirements for various applications.

access to low-cost Internet service capable of supporting streaming video services. That is quite an upgrade from the basic services historically provided through universal service – basic local voice communications service (long distance was available, but at substantial cost). Many advocates justify promoting this class of Internet service as "basic" on the grounds that such high-speed service is needed to ensure access to e.g., educational, health care, and governmental services. However, the reality is that most (and possibly all) of the services that clearly belong in the bundle of basic commitments – affordable access to a reliable communications platform that provides access to emergency services, essential government services and information, employment applications, and even basic e-commerce – do not require a class of service sufficient to support high quality streaming video. Those who think that other, more resource-intensive, services do belong in the bundle should face a stiff burden in advancing their argument.

Indeed, the idea that high-speed broadband is necessary in order to meet these social commitments, and also to provide various educational, healthcare, government and other services, implicitly excludes various disadvantaged communities from these services.[5] The only reason that high-speed broadband is necessary for many of these services is because they have been developed to offer rich multi-media experiences. That is, they use audio and video. This means that they are not accessible to the deaf and blind. In our race to leverage the latest and greatest technologies for various (legitimately important) services, we too often forget that not everyone can avail themselves of those technologies.

Perhaps the most tragic aspect of this premise is that it is largely needless: there is little reason for many of the services being deployed online to *require* rich multi-media. The push for a resource-intensive user experience is in many cases driven by the existence of the technology, not by the needs of the users. This, in turn, drives up consumer need to high-speed broadband.

A better, more modest, regulatory initiative may be to require essential services – the sort of applications that would justify ensuring access to broadband – to be developed so as to not require high-speed broadband. Rather than fueling a race to use more bandwidth-intensive design practices, the government could instead lead the way in the adoption of more efficient, resource-conscious, design practices. This would serve the parallel goals of improving accessibility and decreasing reliance on high-speed broadband.

There is a more fundamental point underlying this idea: engineers optimize – that is they design products around – the simplest and least costly constraints. This means, for example, that if bandwidth is cheap and plentiful, programmers will design applications that make use of that bandwidth. If, on the other hand, bandwidth it costly, programmers will design applications that make less use of data – and consumers will demand such applications. For example as more users access Facebook with a mobile device, Facebook has re-engineered its mobile platform to decrease average monthly data use from 14MB/mo to 2MB/mo. Not only does this lower long term operating costs for Facebook, the lowered data requirement of the platform encourages users to access it more. Or consider recent research that computer users on metered Internet connections are more concerned about viruses and other harmful programs – thus they expend more resources to keep their computers free of such software to keep their monthly Internet bills lower.

And consider that in environments where bandwidth is scare, for example India, Pakistan, and parts of Africa, engineers and entrepreneurs conceive applications from the beginning as needing to function within strict bandwidth constraints. Video conferencing and streaming video applications need to be delivered on less than 1 mbps connections, so they design technologies that make more efficient use of bandwidth than do engineers in economies where bandwidth is cheaper and greater.

5 See Premise Two, *infra*.

Recent telecommunications policy discussions have increasingly embraced ideas of dynamic competition and innovation. In the context of network neutrality, for instance, the FCC has made use of the idea that there is a "virtuous cycle," where openness today drives innovation in application development, which in turn will drive increased consumer demand for broadband.[6] But this cycle need not be "virtuous." If we peg required bandwidth floors to a level sufficient to accommodate the most bandwidth intensive applications, this will tend to increase the bandwidth consumed by all applications by virtue of removing bandwidth as a constraint – this, in turn, will increase the amount of bandwidth that needs to be offered. The resulting incentive structure unravels, creating a constant upward pressure. A policy that implements such an incentive structure has the perverse effect of supporting – even incentivizing – lazy innovation and poor design practices.

A critical question – the most important one – about these services is often overlooked: where is the consumer in all of this? Those advocating high-speed broadband as a universal service often have more to gain from such programs than the median consumer. Firms such as Google, that provide services and applications that run over communications infrastructure, are clear beneficiaries; as are networking equipment manufacturers. Politicians, too, often have much to gain from this strategy, as the costs of provisioning these networks are not transparent to voters and indirectly bourn. And the academy is more likely to reward academics who promote regulatory programs that appear to advance social needs than those who argue against programs that appear to benefit the public interest.

But just as communications technologies and the services that they facilitate are diverse, so too are consumer preferences. It is absolutely the case that there are basic services to which we should do our best to ensure that everyone has reasonable access. But today we need to think more carefully about what these services are than we have historically needed. Most important, we should resist the urge to treat every American as though he or she has the same needs and wants as Washington, Silicon Valley, and academic policy makers.

Along these lines, the meaning of "universal service" is long past a need for review. Returning to the earlier discussion of how the basic unit of transmission has changed – from a unit capable of supporting the full range of telecommunications services to a range of units capable of supporting a range of services – the central question that "universal service" faces is what services need to be universal. There is a strong argument, for instance, that the basic service universally available should be sufficient to support access to basic news and information, health, educational, and governmental services. There may be some argument that such a connection should be capable of supporting basic online video services. But there is only a much weaker argument that high-definition, or even 4K, online video needs to be universally available.

Adding to this, we should also remember that broadband is rarely, if ever, a final product. Consumers don't pay for Internet service for the sake of having Internet service.[7] Rather, Internet access is merely an input that enables consumption of online goods and services. Universal Service support – and in many ways broadband marketing generally – therefore, should be developed around actual consumer demand and delivered in ways relevant to consumers.

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[6] See *infra*.

[7] For some consumers it may at times appear that they do. Consumers may, for instance, prefer having the highest-speed Internet available, even if their usage patterns don't benefit from that speed as compared to a lower-speed option. But even in these cases, the consumer likely derives some extrinsic value from having the higher-speed option, for instance through indicating status. In this sense, high speed Internet may be a form of Veblen good. In other cases, consumers simply may not appreciate how much speed their particular usage patterns require, so opt to purchase the highest-speed option available.

It may make sense, for instance, to reframe universal service goals to focus on enabling certain classes of applications. Rather than define universal service as generic high-speed Internet (itself defined at, e.g., "4 mbps down/1 mbps up" service), universal service could be defined as service sufficient to support a minimum bundle of services. That bundle may include, for instance, healthcare, education, employment, and government, services, common news and information services, basic online video services, and VoIP and other common over-the-top services.

There are two basic challenges to such an approach. The obvious challenge is defining what services should be included in this basic bundle – though this is the sort of task routinely overseen by regulators. A more subtle and potentially difficult challenge is that it may create an incentive for application designers to make excessive use of bandwidth. This incentive may exist because access providers would be required to provide a bundle of services sufficient to support those applications, no matter how inefficiently designed they may be. This approach to defining universal service, therefore, would need to be careful to take this into consideration. It may, for instance, be possible to competitively benchmark the bandwidth (and other) requirements of like-services in determining whether an access provider is sufficiently provisioning its network.[8]

More generally, the Commission may want to encourage similar experimentation with how Internet services are marketed and sold. Few consumers have an appreciable understanding of the difference between 6 mbps and 25 mbps service, or of the difference between the resources required to deliver an email as compared to a 60 minute streaming video. The norm of marketing Internet access in terms of peak download and upload capacity is confusing to consumers, ignores the possibility of service commitments and competition along other metrics (e.g., latency or jitter), and is generally irrelevant to what consumers care about. It would almost certainly be more relevant and less confusing to consumers were Internet access to be marketed in terms of the services that they support. And, perhaps even more important, such marketing would likely provide consumers with more meaningful remedies should access providers fail to live up to these promises. An express commitment that a given service package is capable of supporting HD streaming video, for instance, would more likely create an enforceable contractual commitment than the current approach to marketing; it would make enforcement actions by the FCC or FTC easier to bring and more likely to be successful; and it would require Internet access providers to upgrade their infrastructure to match changing requirements of various services. While anathema to the views of many policy advocates – those, for instance, who would view this idea as turning Internet access into a "cable-like" system – it could be among the most consumer-friendly of possible changes to how Internet services are marketed and provided.

A final possible innovation to universal service would be to allow localities to "buy out" of the system. While universal service, as defined by the FCC, may be an important federal goal, local municipalities may face other priorities, or have other ideas about how to best achieve the universal service goals. Just as we should recognize consumer welfare and preferences should be the loadstone of telecommunications policy, we should recognize that municipal governments may have a better sense of the wants and needs of a local population than the federal government. It may therefore be reasonable to allow local governments to "buy out" of federally-administered universal service programs by accepting a one-time payment of some amount less than that which would be invested in the locality through the federal program.

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[8] For instance, if a party were to raise concerns that an access provider's network was insufficiently provisioned to handle a certain quality of streaming video offered by a given service, that concern could be rebutted by demonstrating that other services (including those offered by the provider's own vertically-integrated offerings) were capable of delivering similar quality video.

II. Premise Two: High-speed broadband is necessary for education, health, government, and other social services

The idea that high-speed broadband is necessary for education, healthcare, and other social and government services is related to the first premise. This premise is problematic both because it is factually dubious, and also because its power is based in an implicit appeal to inherently emotional issues. It creates a sense that the only way to support high-quality education, provide access to healthcare and employment opportunities, and address concerns about the digital divide is to support a specific broadband policy – namely one of extensive government subsidies for high-speed broadband. As recognized in the previous installment, broadband Internet service and other communications technologies support many important services that should be viewed as basic social commitments – but the focus in telecom policy debates should be on ensuring Internet access that is sufficient to realize these basic social commitments, not on subsidizing higher-speed luxury services or services that the market would otherwise provide at competitive prices.

The first, most important response to this premise is that high-speed broadband connectivity isn't typically needed for education, healthcare, or other social services. It is especially true that the bandwidth sufficient for high-quality video streaming services – a critical benchmark for most broadband advocates – isn't necessary for these services. For example, today's system requirements for video conferencing applications, including programs routinely used for distance education and MOOCs ("Massive Online Open Courses"), is in the 1-2 mbps range.

The developers of these applications recognize that their products need to work even in low bandwidth environments, so design their applications to even without high-speed broadband. Adobe Connect, for instance, only requires 512 kbps connection for classroom participants. Coursera, a popular MOOC platform developed by Stanford, Princeton, the University of Michigan, and the University of Pennsylvania and that today comprises a consortium of over 100 universities, has recently announced a mobile-optimized app that allows students to view recorded class sessions on their mobile devices. Similarly, Adobe Connect has a mobile application that allows for real-time video participation.

More bandwidth is of course preferable, but typically is not required for basic operation. In technical terms, it is important to recognize that most of the video delivered in the MOOC setting is highly compressible. Unlike television or movie content, most of the frame is relatively static, with relatively simple background settings. Such video is readily and substantially compressible. Moreover, because MOOC software needs to support the typical student's computer hardware (e.g., a moderate resolution monitor displaying both in-class video and other class-related materials on a single screen), the typical resolution of video in the online teaching environment will be far below that of HD streaming video services.[9] Additionally, and perhaps counterintuitively, MOOCs with their large enrollments generally require less bandwidth than smaller online teaching settings. The large class sizes mean that most video will be delivered one way, from the instructor to the students – due to the large number of students, interactivity will be achieved through non-video means (such as quizzes or written questions moderated by an in-class assistant). In such a setting, the user experience will be less sensitive both to bandwidth and latency variations.

[9] See also Arnold Kling, *Many-to-One vs. One-to-Many: An Opinionated Guide to Educational Technology* (Sept. 12. 2012), available at Many-to-One vs. One-to-Many: An Opinionated Guide to Educational Technology (arguing that the more fundamental change to education enabled to technology is many-to-one teaching through adaptive textbooks, rather than the massive one-to-many model of teaching facilitate by MOOCs).

This reveals another often overlooked aspect of broadband policy debates: bandwidth isn't the only, and often isn't the most important, metric. Latency (the time it takes a packet of data to traverse the network), jitter (the chance in latency between packets), and packet loss (the percentage of packets of data that never make it across the network) are incredibly important metrics, especially for applications in education and health care – applications where the user may need to interact in real time with a teacher, classmates, or healthcare professional. Substantial or irregular latency and packet loss can lead to jumpy, broken, or lost audio and video – it is far preferable to have a lower resolution but consistent-quality audio and video than high-quality but unreliable audio and video.

The idea that latency and packet loss can be as important as bandwidth is not new. But it is one that plays little role in contemporary policy debates. The failure to appreciate the importance of these metrics is a serious flaw in these policy discussions. It is akin to having a transportation policy that focuses on miles of highway constructed but pays no attention to whether those highways actually decrease commute times or accidents.

Indeed, where education, healthcare, or other services require high-performance Internet service, one important alternative to provisioning high-speed Internet service in high-cost areas is to rely instead on quality of service (QoS) and prioritization techniques to ensure sufficient performance over lower-speed links. This would not allow a service requiring an average 2 mbps throughput to operate over a 1 mbps link – but, where such a service may not function well on a 3-4 mbps connection, prioritization could allow it to operate over a lower-speed (e.g., 2 mbps) link. To make sure this paragraph's suggestion is clear: lower-speed links that do not adhere to "network neutral" routing may often be able to support the same services that would require a higher-speed (and higher-cost) connection on a neutral network.

Another important, and often overlooked, metric, is adoption. In recent years survey evidence, such as the Pew Research Center's study on Internet and American Life, has made clear that availability and price are not the primary reasons that people in the United States do not have Internet access. Rather, low adoption is driven by concerns about usability, relevance, and worries about online harms. These concerns are particularly salient among older demographics – those who would be most likely to benefit from (or even need) Internet-based healthcare, government, and other services.

Other issues with the idea that high-speed broadband is necessary for these services become clear when looking at each service individually. In the case of health care, for instance, it is unlikely that residential users would have any need for the sort of telemedicine devices that require high-speed connections.[10] Rather, consumer-grade healthcare applications are more likely to be used for monitoring and reporting – applications that either send occasional large bursts of data or send consistent, possibly latency-sensitive, small packets of data, and that in either case do not require particularly high-speed connections. The greater challenge for these applications is likely to come from the multiplicity of such devices – the so-called Internet of Things, where dozens of devices in one home or millions of devices on larger networks. There is concern that millions or billions of devices, each sending small bursts of data, will overwhelm networks. In such cases, even if the network provides sufficient bandwidth, it may not be able to handle the multiplicity of connections. To use the comparison with highways, the more cars you put onto a single road, the more accidents and delays there will be, independent of the speed limit or number of lanes. A network transmitting 100 million small packets per

[10] Such devices include equipment such as MRIs and other imaging devices.

second will be far more congested than one transmitting 10 million large packets per second, even if they are both transmitting the same total amount of data.[11]

It is important to distinguish between consumer-oriented Internet service and Internet service used by institutions such as schools and hospitals. There is a much stronger case that institutions need access to high-speed Internet service. Schools, for instance, often need to support simultaneous Internet use by hundreds of teachers and students. And, while each student remotely connecting to a video-based classroom may only need a modest amount of bandwidth, on the institutional side, connecting several students to the classroom will require a much greater amount of bandwidth for the institution as a whole.[12] There is legitimate concern that students need access to some sufficient level of bandwidth at home for educational purposes. But to date there have not been serious efforts to determine how much bandwidth is "sufficient" for educational purposes – rather, advocates' estimates have tracked median consumer bandwidth preferences, which in turn track the bandwidth requirements for high-definition streaming video content.

Similarly, the amount of bandwidth needed by a hospital for real-time telemedicine applications, even for things as simple as transferring a patient's MRI data to a doctor in another hospital for a "virtual" consultation, can be substantial. So, it is certainly the case that that these institutions need for high-speed Internet access. But the market for these sort of institutional connections is much different from – and much more competitive than – the market for consumer-oriented Internet access. Still, as is usually the case for commercial-quality products compared to their consumer-oriented counterparts, Internet connections suitable to meet these institutions' needs are often quite expensive, especially for public and non-profit institutions such as schools and hospitals. While current programs to assist in getting these institutions online (e.g., E-Rate) have their problems, there is a much stronger argument to be made for government support of these institutional Internet-access needs than for government support of consumer-oriented high-speed Internet access.

It is undoubtedly the case that broadband Internet can be an important tool for various educational, healthcare, and other social and government services. But speed – especially "high-speed" – isn't the only or most important metric to consider when provisioning these services. It is unfortunate that advocates of government-sponsored consumer high-speed broadband Internet use the indisputable importance of services such as healthcare and education to buttress their argument for government intervention in the high-speed broadband market. At best, this represents a misunderstanding of these services' actual requirements. It may also represent a willingness on the part of broadband advocates to assert their idealized view of how the Internet should be used over the needs of those who actual will rely on these services. At worst, it is a deliberate tactic, being used as an emotional appeal to advocate for a preferred policy that is not otherwise supportable by technical requirements.

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[11] Importantly, most network switches are provisioned in terms of the number of packets they can switch per second, as the switching logic is more computationally intensive than copying data from an input port to an output port. For instance, the standard line-rate gigabit Ethernet port can switch 1,488,100 packets per second. If the typical packet size is 100 bytes, which may be typical for machine-to-machine communications, the network will only be able to run at less than 20% of its provisioned capacity.

[12] That said, a review of studies of how much bandwidth is needed by educational institutions suggests that the required bandwidth is often over-estimated. For instance, in presentations made at George Mason University's Information Economy Project, both Robert Kenny and Scott Wallsten have raised concerns about these studies, finding basic errors in some (such as misattributing the bandwidth requirements of a small town for those of a single school in that town) and expressing concern that many of these studies are developed by hardware manufacturers with an interest in selling equipment.