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The Myth of Network Neutrality and the Threat to Internet Innovation

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Executive Summary

A quarter century ago, there was a very influential paper that shaped thinking on how best to design what we now call the Internet. The article offered a design principle called “end-to-end.” The idea was to keep the inner part of a computer network as simple as possible and allow the “intelligence” to reside at the edges of the network closer to the end user.

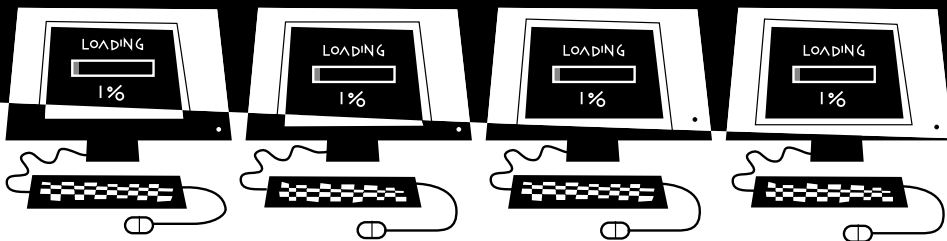
Proponents of this grand design have pushed for net neutrality legislation, which would discourage access providers from placing any intelligence in the inner part of the network. Their ideal of a “dumb network” would be achieved by preventing access providers from charging content providers for prioritized delivery and other quality enhancements made possible by placing intelligence at the center of the network.

This essay examines the merits of the end-to-end argument as it relates to the net neutrality debate. First, we review the evidence on the current status of the Internet, concluding that all bits of information are not treated equally from an economic standpoint. Second, we demonstrate that because consumers and business place a premium on speed and reliability for certain kinds of Internet services, network owners and specialized service providers have responded with customized offerings. Third, we consider our findings in the context of the current legislative proposals involving net neutrality. Fourth, we consider some of the problems with regulating prices and quality of service, which is essentially what the net neutrality proponents propose. Our principle conclusions are that the end-to-end principle does not make sense from an economic perspective and that further regulation of the Internet is not warranted at this point in time.

Portioning Bit by Bit

The Myth Of
Network Neutrality
And The
Threat To
Internet Innovation

*By Robert W. Hahn
and Robert E. Litan*



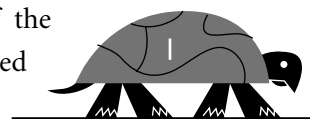
A quarter-century ago, three MIT computer scientists wrote a paper that shaped the thinking on how best to design what we now call the Internet, extolling a design principle dubbed “end to end.” The idea was to keep the inner part of a computer network as simple as possible and allow the “intelligence” – that is, the ability to prioritize one data packet over another – to reside at the edges of the network, closer to the end-user.

Several leading Internet thinkers, including Larry Lessig of the Stanford University Law School, have suggested that end-to-end design has led to a huge amount of innovation in the ways the Internet is used. By treating all bits of data equally, entrepreneurs at the edges of the network can compete – or so the argument goes – to bring consumers new products and applications

Many proponents of this grand design have pushed for “net-neutrality” legislation, which would discourage Internet access providers from placing any intelligence in the inner part of the network. Their ideal of a “dumb” network would be achieved simply by preventing access providers from charging content providers for priority delivery or other quality enhancements, like guaranteed minimum bandwidth.

The net-neutrality debate is especially important today. Access providers are in the midst of a multibillion dollar campaign to upgrade their networks, using a mixture of capacity expansion and electronic enhancements to carry broadband content, including multiple HDTV signals. Under net-neutrality regulation, they would be forced to meet this growing demand with increases in capacity only, which is a very costly solution for both access providers and their subscribers. And the prospects for such legislation have improved drastically because key Democratic supporters are back in leadership positions.

Here, we review the evidence on the current status of the Internet, concluding that all bits of information are not treated equally from an economic standpoint.



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Second, we show that because consumers and businesses place a premium on speed and reliability for certain Internet services, network owners and specialized service providers have responded to market incentives with customized offerings. We think this is a good thing – not the initial step toward crony Internet capitalism, as many net-neutrality advocates would argue.

Third, we consider current Internet regulation proposals, concluding that they are misguided and even extreme by the standards of those advocating net neutrality. In particular, the proposals would require access providers that offered enhanced quality to one content provider to make the same level of service quality available to all content providers at no extra charge.

Fourth, we consider some of the problems with regulating prices and quality of service, which is essentially what the net-neutrality proponents want. Pricing flexibility is a good thing in general, and there is no reason to believe that it is not a good thing here. In our view, the antitrust laws are adequate to police access providers who have incentives to discriminate among content providers in the provision of service quality.

THE MYTH THAT ALL BITS ARE TREATED EQUAL

The Internet is literally a network of computers. The network moves data to and from those computers. The network includes a set of routers – think of highway interchanges – connected by long wires. Packets of data get passed from one router to another, until they

arrive at their destination. The packets travel at different speeds for different kinds of users, with the speed determined by a number of factors, including congestion on the network and bandwidth capacity at the point of connection. Many users subscribe to services that allow them to use the Internet whenever they want at specified maximum speeds. Thus, a typical consumer may pay \$15 per month for a minimum speed of 786,000 bits per second and \$30 for a minimum four times greater.

The net-neutrality debate is largely about whether access providers have the right to give some data preferential treatment over other data – and then charge content providers for those preferences and for other enhanced services made possible by the technological ability to discriminate among data packets. Content providers could either pass a share of that surcharge for priority delivery on to their customers or use the enhanced capacity to generate revenue in myriad other ways – say, through advertising.

The original proponents of the end-to-end principle argued that most features in the middle of a communications system are redundant if the end-user must implement them a second time. This viewpoint leads to the model of a dumb network with intelligence built only into its edges. According to Edward Felten, a Princeton University computer science professor who is a proponent of the end-to-end principle, the routers in the middle of the Internet “forward packets with only minor processing – all the heavy lifting takes place on the transmitting and receiving computers.” Felten argues that keeping things this way makes sense in large part because computers at the edges of the network are owned and controlled directly by end-users.

This kind of design is not only more efficient, argues Felten, but would also encourage innovation at the edges of the network. In

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particular, Professors Lessig and Tim Wu of Columbia University Law School maintain that content providers will refrain from innovation if access providers have the ability to discriminate against some of them.

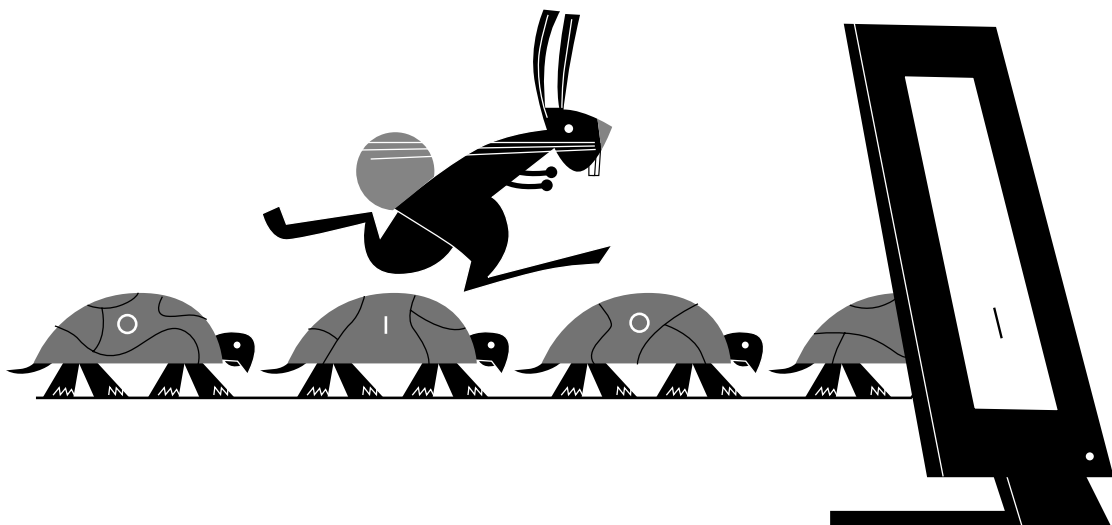
This may sound reasonable on its face. But innovation among content providers does not appear to be slowing in spite of the lack of assurances that Lessig and company wish to legislate. The popularity of online search systems created by Yahoo and Google has given way to upstart social networks like MySpace and YouTube and movie-delivery sites like Vongo. In short, the Internet is not end-to-end now and was never designed to be strictly neutral.

Most of the early writings on Transfer Communication Protocol/Internet Protocol (TCP/IP) – the technical rules of the Internet – are contained in a series of informal papers known as Requests for Comments. These papers were not prepared by consultants on behalf of commercial interests. Instead, they functioned much like fodder for a chat room, offering design concepts for the Internet and applications of computer networking.

Interestingly, many of the contributors

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recognized the need to offer priority to some packets over others. A 1974 Request for Comments, whose authors included Google's current chief technologist who is now a major proponent of net neutrality today, explained that outgoing packets should be given priority over other packets to prevent congestion on the ingoing and outgoing pipe. A 1981 Request for Comments explained that precedence – a measure of importance of the data stream – could be used as a means of differentiating high-priority traffic from low-priority traffic. And a 1994 Request for Comments predicted that bandwidth constraints would eventually harm the delivery of real-time applications (think of live voice communication), and suggested that an arrangement for some traffic to receive preferred treatment was advisable.



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These early writings on the Internet indicate that prioritization has always been considered an important design characteristic for TCP/IP – a sharp contrast to the romantic ideal of the end-to-end principle.

Even if that principle had been applied faithfully in the early days of the Internet (which it was not), it is virtually irrelevant today. There are currently several ways that suppliers of information on the Internet manage to get selected content and applications to users faster and more reliably. For their part, end users can also buy services to improve speed and reliability. Access providers like AT&T, Verizon and Comcast can support quality-of-service (QoS) technology, which can give priority to specified traffic.

The big access providers all compete by differentiating QoS. Other firms that are not

access providers, including Akamai Technologies, CacheFly, Limelight Networks and Panther Express, offer similar services to content providers. Akamai, for example, provides content-acceleration service by caching content closer to the end-user for more than 2,000 customers. There are also a large number of content providers, ranging from search engines like Google to businesses like eBay, that arrange to get their “products” to the market more quickly and reliably. Google sets up server farms packed with computers to store all of its content for end-users. Other firms are providing QoS for applications, like business-network alarm monitoring, that require a high degree of security.

By the same token, many applications depend on QoS to perform well. Popular QoS-needy applications include streaming multi-

media, online gaming, voice-over-Internet protocol phone service, video teleconferencing, alarm signaling and safety-critical applications like remote surgery.

Online gaming provides a good example of how and why all bits are not treated equally by access providers. If there is even a small delay in response time with some games or degradation in the quality of the video stream, product quality declines unacceptably. The suppliers of these games will frequently pay Web-hosting companies to offer faster and more reliable service than they could achieve with their own servers. They may pass the costs through to their customers. For example, users pay between \$13 and \$15 a month to subscribe to the popular multiplayer online role-playing game World of Warcraft, part of which presumably goes to maintain the quality of the gaming network.

BIT EQUALITY AND NET-NEUTRALITY PROPOSALS

The net-neutrality bills before Congress represent an attempt to regulate the pricing of service quality by an access provider. But, as is demonstrated in virtually all other sectors of the economy, pricing flexibility is generally a good thing.

Net-neutrality proponents nonetheless argue that Internet access providers – cable companies, phone companies, media conglomerates – wield too much power over content providers, and as a result, cannot be trusted to charge fairly for service quality. Without such price regulation, they say, access providers might one day monopolize the content markets by charging excessive prioritization fees to outside content companies. Moreover, if upstart content providers are protected from the possibility of price gouging, they will be encouraged to innovate faster than they do today.

Net-neutrality proponents assert that regulation before the fact (as opposed to anti-trust suits after the fact) is necessary because the harm from anticompetitive behavior (in terms of less innovation by content providers) could not be remedied appropriately by either injunctive relief or fines. This line of argument discounts the counterargument – namely, that there is a possibility that such regulation could generate harm that far outweighs the potential benefits.

The net-neutrality proposals would achieve their objective by imposing non-discrimination requirements on access providers in the provision of QoS to content providers. Non-discrimination typically implies similar treatment for similar types of customers. For example, a non-discrimination rule for, say, a newspaper would require that a 2-inch-by-2-inch advertisement cost the same for all advertisers, regardless of the nature of the ad or its placement. Non-discrimination has a superficial appeal, but it is not always consistent with economic efficiency. Suppose that advertiser A was willing to pay 10 times more than advertiser B for an advertisement, but the newspaper is constrained to charge both advertisers the same price. Economic theory suggests that the total benefits to buyers and sellers can be increased by raising advertiser A's price while slightly lowering advertiser B's price – much the way air travelers who book at the last minute pay more than vacationers who book months ahead.

Under each of the net-neutrality bills in Congress, however, non-discrimination in the pricing of service quality means something more extreme: if a broadband provider offers enhanced service to any individual content provider, it must offer the same enhancements to all content providers at no extra charge. The idea is to stymie efforts by any content provider to secure enhanced service

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quality from access providers and instead to force all contracting for quality to occur between broadband providers and end-users.

Note, by the way, that these bills generally do not distinguish between broadband services offered by access providers and those offered by the companies that maintain the Internet “backbone,” and they would presumably impose identical restrictions on both types of networks. Thus, because much of the enhanced QoS in the marketplace today resides at the backbone layer, those offerings would presumably be in jeopardy.

One bill, for example, known as H.R. 5273, sponsored by Representative Ed Markey, a leading Democrat on telecom issues, explains in its preamble that “a network-neutrality policy based upon the principle of nondiscrimination is essential to ensure that broadband telecommunications networks, including the Internet, remain open to independent service and content providers.” The bill would require that an access provider “not discriminate in favor of itself in the allocation, use or quality of broadband services or interconnection with other broadband networks.” In other words, an access provider must offer the same service quality for its own content and unaffiliated content. Finally, if an access provider offers a given service quality to one content provider, then it must offer the same service quality to all content providers free of charge.

Another bill, S. 2360, sponsored by Senator Ron Wyden, an Oregon Democrat, would similarly prevent an access provider from discriminating in the provision of QoS to content providers, and it would ban any charges for QoS. The bill would also prohibit an access provider from discriminating with respect to bandwidth.

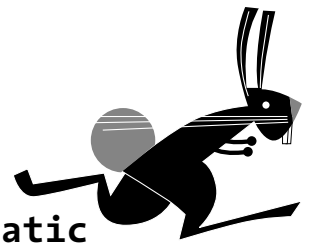
Requiring that service quality be priced at zero for content providers could have dra-

matic effects on existing contracts between access and content providers, as those content providers would presumably seek to renegotiate their terms for service quality once the regulation had passed. Why should online gamers have to pay for QoS under existing contracts if everyone else is getting the same service quality free?

FIRST, DO NO HARM

As the evidence on prices implies, the market for broadband access is highly competitive. Between 1999 and 2005, the price of a DSL connection by phone line (with a download speed of 1.5 megabits/second) has dropped from roughly \$80 a month to about \$30. While the absolute price of cable service has not declined as rapidly, the quality-adjusted price has declined significantly, as cable connection speeds have more than doubled while prices held steady. Where there remains insufficient competition, the government’s existing antitrust authority is sufficient to police an access provider’s behavior. If, for example, a provider with monopoly power offered high quality service to an online gaming provider but refused to sell the same level of service to an unaffiliated voice-over-Internet protocol provider in order to protect its own subsidiary in the phone business, the antitrust laws would open the access provider to a lawsuit.

But net neutrality would do more than gild the lily. Broadband access providers would likely react to non-discrimination provisions in ways that would hardly serve the interests of content providers and content users. An access provider could comply with a non-discrimination provision either by withdrawing its enhanced QoS offering from the marketplace or by replacing its tiered QoS offerings with a one-size-fits-all QoS plan. Under either scenario, the total benefits to consumers would diminish.



Although it may have represented a democratic ideal two decades ago, the end-to-end principle is a fiction today and should be treated as such.

To borrow another example from the airline industry, imagine a rule that required carriers to charge all customers the same price. One solution to this uniform pricing constraint would be for the airline to replace its first class and economy seats with some blended offering inferior to first but superior to economy. To preserve revenues, the airline would be forced to set the price of the blended offering above the price of the economy seat. Customers who would have preferred to pay a lower price and receive a smaller seat would clearly suffer under such a regime, as would people who were priced out of the market. Moreover, business and first-class travelers who wanted better service and were willing to pay for it would have to settle for aching knees, pretzels instead of mixed nuts, and the occasional misbehaving child.

Entrepreneurs wishing to deliver content that depends critically on QoS would have no easy way to arrange it. Accordingly, they would likely divert their resources and creative energies to Internet uses that do not require high service quality.

Consider the next generation of online video. Although today's video clips may not require exceptional bandwidth or reliability, as online video is narrowcast in high-definition format and takes on a more interactive nature, it is not much of a stretch to envision the day when content providers will be stymied by lack of resources. Thus, as a condition of investing resources into the development of online video, companies like Apple, Google, Vongo and Sony need assurances that

contracting for higher service quality with access providers will be legal.

JUST SAY NO

Although it may have represented a democratic ideal two decades ago, the end-to-end principle is a fiction today and should be treated as such. Policymakers should look at how the Internet really functions from both a technical and an economic perspective. Modern networks are capable of acting more intelligently than earlier networks, which means that access providers now have the ability to prioritize data for those applications that depend critically on it. If content providers are willing to pay for enhanced quality, there is no good reason for regulators to deter them.

What will protect upstart content providers in the absence of net-neutrality regulation? Two things: The first, as noted earlier, is antitrust laws that deter access providers with demonstrated market power from abusing their positions. The second is a competitive environment in which the prospect of gaining market power over broadband access is remote. Along with 25 other economists, from William Baumol to Alfred Kahn to Hal Varian, we recently signed a statement calling for an end to local franchising regulations for broadband and the federal transfer of more wireless spectrum to private broadband uses (see www.aei-brookings.org/publications/abstract.php?pid=1044). And, we would argue, it is here – and only here – that there is room for government regulation that is likely to do more good than harm. **M**