FROM EDGE TO CORE: PERSPECTIVE ON INTERNET PRIORITIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS AND
TECHNOLOGY

OF THE

COMMITTEE ON ENERGY AND
COMMERCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

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[1] The information has been retained in committee files and also is available at *https://docs.house.gov/Committee/Calendar/ByEvent.aspx?EventID=108168.*

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TUESDAY, APRIL 17, 2018

House of Representatives,
Subcommittee on Communications and Technology,
Committee on Energy and Commerce,
Washington, DC.

The subcommittee met, pursuant to call, at 10:16 a.m., in room 2322, Rayburn House Office Building, Hon. Marsha Blackburn (chairman of the subcommittee) presiding.

Members present: Representatives Blackburn, Lance, Shimkus, Latta, Guthrie, Olson, Bilirakis, Johnson, Long, Flores, Brooks, Collins, Walters, Costello, Walden (ex officio), Doyle, Welch, Clarke, Loebsack, Ruiz, Dingell, Eshoo, Engel, Matsui, McNerney, and Pallone (ex officio).

Staff present: Jon Adame, Policy Coordinator, Communications and Technology; Daniel Butler, Staff Assistant; Robin Colwell, Chief Counsel, Communications and Technology; Kristine Fargotstein, Detailee, Communications and Technology; Sean Farrell, Professional Staff Member, Communications and Technology; Adam Fromm, Director of Outreach and Coalitions; Elena Hernandez, Press Secretary; Tim Kurth, Deputy Chief Counsel, Communications and Technology; Lauren McCarty, Counsel, Communications and Technology; Austin Stonebraker, Press Assistant; Evan Viau, Legislative Clerk, Communications and Technology; Hamlin Wade, Special Advisor, External Affairs; Jeff Carroll, Minority Staff Director; Jennifer Epperson, Minority FCC Detailee; David Goldman, Minority Chief Counsel, Communications and Technology; Jerry Leverich III, Minority Counsel; Jourdan Lewis, Minority Staff Assistant; Dan Miller, Minority Policy Analyst; Andrew Souvall, Minority Director of Communications, Outreach and Member Services; and C.J. Young, Minority Press Secretary.

Mrs. BLACKBURN. The Subcommittee on Communications and Technology will now come to order.

You notice that we are starting just a couple of minutes late. We understand that the Environment hearing downstairs started a couple of minutes late, and we are trying to accommodate the chairman of the full committee and the ranking member of the full committee to get up here for their opening statements.

I now recognize myself for 5 minutes for an opening statement.

OPENING STATEMENT OF HON. MARSHA BLACKBURN, A REP-RESENTATIVE IN CONGRESS FROM THE STATE OF TEN-NESSEE

Good morning, everyone, and to our witnesses, thank you for being here, and welcome. We are here to talk about prioritization. Not just paid prioritization—all prioritization online.

Despite what some of my colleagues sometimes seem to think, prioritization is not a dirty word. The internet, in fact, is based on it.

In the net neutrality conversation, there is a common misconception that the internet is one big highway where all the cars travel at the same speed and we cannot allow for any fast lanes to exist without causing a big traffic jam for everybody else.

It is something like the picture that we are going to put up on the screen. It ran into a jam.

[Laughter.]

Mrs. BLACKBURN. Yes, we are in need of some prioritization here. OK. No, that's the wrong picture. See if we can—OK.

Our witnesses today know that this could not be further from the truth, and the next picture we are going to put up in fact is probably a lot closer to reality, but it is still an oversimplified idea of the internet: different connections, agreements, prioritization, depending on the needs.

And the amazing new capabilities that we will experience on next-generation networks will be realized not only through innovation in the chips and the servers and the infrastructure, but also through even more efficient and effective prioritization.

I would also point out that, in real life, all sorts of interactions are prioritized every day. Many of you sitting in this room right now paid a line-sitter to get priority access to this hearing.

In fact, it is commonplace for the Government itself to offer priority access to services. If you have ever used Priority Mail, you know this to be the case.

And what about TSA pre-check? It just might have saved you time as you traveled today. If you define paid prioritization as simply the act of paying to get your own content in front of the consumer faster, prioritized ads or sponsored content are the basis of many business models online, as many of our Members pointed out during the Facebook hearing last week.

Prioritization is sometimes crucial from a public policy standpoint. Just as we all want the ambulance and the fire truck to be prioritized over the rest of the traffic on the highway, there is a need for voice packets to be prioritized over data packets to make sure that your 9-1-1 calls get through first, and there are lots of other examples where we can all agree that certain data and certain applications should be prioritized on the network.

One of our witnesses is pioneering a technology to provide real-time audio support to the visually impaired, describing the surroundings and the nonverbal interactions taking place around the user.

Other examples that our witnesses will discuss today include telemedicine and autonomous vehicles. Prioritization of data on the network is not unique or uniquely harmful.

It may be an uphill climb, but what we are trying to do with this hearing is to leave aside the simplistic "fast lane" talking points and kick off a more realistic discussion on the subject.

My net neutrality bill left out the old language banning all paid prioritization because I believe that we need a more nuanced approach and a more thorough and thoughtful discussion.

For the Government to consider a ban on any prioritization on the internet, paid or unpaid, we need a better understanding of what specific harmful conduct we are trying to address and a better understanding of how to leave the door open for the beneficial prioritization that's necessary to keep the internet as we know it working and to bring even more benefits to consumers.

[The prepared statement of Mrs. Blackburn follows:]

PREPARED STATEMENT OF HON. MARSHA BLACKBURN

Good morning, everyone, and welcome to our witnesses. We are here to talk about prioritization. Not just paid prioritization—all prioritization online. Despite what some of my colleagues sometimes seem to think, prioritization is not a dirty word. The Internet is based on it.

In the net neutrality conversation there is a common misconception that the Internet is one big highway, where all the cars travel at the same speed and we cannot allow for any fast lanes or toll lanes to exist without causing a big traffic jam for everybody else. Something like this picture:

Picture of traffic jam

Our witnesses today know that this could not be further from the truth. This picture is a lot closer to reality, in fact it probably still gives you an oversimplified idea of the internet. Different connections, different agreements, and different prioritization, depending on needs.

Picture of mixing bowl interchange

And the amazing new capabilities that we will experience on next generation networks will be realized not only through innovation in the chips and the servers and the infrastructure, but also through even more efficient and effective prioritization.

I would also point out that in real life, all sorts of interactions are prioritized every day. Many of you sitting in this room right now paid a line-sitter to get priority access to this hearing. In fact, it is commonplace for the Government itself to offer priority access to services. If you have ever used Priority Mail, you know this to be the case. And what about TSA pre-check? It just might have saved you time as you traveled here today. If you define paid prioritization as simply the act of paying to get your own content in front of the consumer faster, prioritized ads or sponsored content are the basis of many business models online, as many of our Members pointed out at the Facebook hearing last week.

Prioritization is sometimes crucial from a public policy standpoint. Just as we all want the ambulance and the fire truck to be prioritized over the rest of the traffic on the highway, there is a need for voice packets to be prioritized over data packets to make sure that your 9-1-1 call gets through first. And there are lots of other examples where we can all agree that certain data and certain applications should be prioritized on the network. One of our witnesses is pioneering a technology to provide real-time audio support to the visually impaired, describing the surroundings and the nonverbal interactions taking place around the user. Other examples that our witnesses will discuss today include telemedicine and autonomous vehicles.

Prioritization of data on the network is not unique, or uniquely harmful. It may be an uphill climb, but what we are trying to do with this hearing is to leave aside the simplistic "fast lane" talking points and kick off a more realistic discussion on the subject. My net neutrality bill left out the old language banning all paid prioritization because I believe that we need a more nuanced approach, and a more thorough and thoughtful discussion. For the Government to consider a ban on any prioritization on the Internet, paid or unpaid, we need a better understanding of what specific harmful conduct we are trying to address, and a better understanding of how to leave the door open for the beneficial prioritization that's necessary to keep the Internet as we know it working, and to bring even more benefits to consumers.

Mrs. BLACKBURN. Now I recognize the ranking member, Mr. Doyle, for 5 minutes for an opening statement.

OPENING STATEMENT OF HON. MICHAEL F. DOYLE, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF PENNSYLVANIA

Mr. DOYLE. Thank you, Madam Chair, for holding this hearing and thank you to the witnesses for appearing before us. I'd like to in particular thank Matt Wood, a proud Pittsburgher, for being here today.

This subcommittee is once again discussing net neutrality and the fallout from Chairman Pai's repeal of the 2015 Open Internet Order.

This short-sighted act has created an uncertain landscape where innovators and entrepreneurs trying to develop new services, applications, and devices can be taxed, tolled, or blocked at any time by an ISP.

Prioritization practices that were once required to meet the standard of reasonable network management as judged by Federal experts and network engineering, telecommunications, and competition policy at the FCC will now be determined by an ISP's bottom line.

As I've talked to companies large and small that developed and deployed new applications in the wake of the 2015 net neutrality rules, their message was clear: that the certainty created by the rules was stoking investment and giving certainty to investors and that consumers were benefitting from these new offerings.

A number of companies I talked with were working to deploy services that directly competed with ISPs' own offering at lower prices, bringing what we can all agree is a much needed competition to a stagnant marketplace.

I am deeply concerned that, as we move forward in a world without the open internet rules, ISPs will once again act in anti-competitive ways intended to tamp down competition and consolidate their hold over their consumers.

We have already seen ISPs zero-rate data from their own services and their affiliates while forcing users to either limit usage on competing apps or pay costly overage fees.

If we look at the history of the internet before net neutrality, we find a number of instances where ISPs used their market position to stifle innovation and prevent competitors from bringing new products to market, all while coming to Congress and the Government arguing that they were only thinking about the consumer.

Today, it seems we are adding another chapter to that book. Today, we are talking about the prioritization of the internet content.

If the testimony of a number of our witnesses is to be believed, paid prioritization can bring great benefits to the internet. They claim that the coming flood of data can only be dealt with by prioritizing it and creating incentives and opportunities for Web sites and edge providers to pay to get their packets to consumers before their competitors.

Well, frankly, I don't believe it. We have heard these arguments before. The truth is, giving ISPs the ability to play gatekeeper only

benefits the ISPs and their shareholders, and it significantly hurts innovators and consumers.

More than that, it fundamentally undercuts the level playing field and open marketplace that defines the internet economy.

Now, I have a bill that has 160 co-sponsors in the House with companion legislation with bipartisan support in the Senate to fix this mess.

Our CRA would reinstate the 2015 open internet rules and restore the FCC to its expert oversight role over ISP network practices.

When you look at the polling on this issue, these rules have overwhelmingly bipartisan support with a vast majority of Democrats, Republicans, and Independents, and I hope to work with my friends on the other side of the aisle to make this bill bipartisan as well.

Madam Chair, I'd also like to raise a process issue leading up to today's hearing. Mr. Bennett, who was first to submit his testimony, amended his submission yesterday afternoon in meaningful ways.

I am concerned that many of the changes to Mr. Bennett's written submission were of a substantive and factual nature, and that is of great concern to us.

I don't believe the committee should get into the practice of allowing such last-minute changes. When we have witnesses do this, the committee process breaks down, and it also—it leads to many of us just questioning whether the testimony will be credible.

I'd also like to note that baseball season is starting here in Congress. I had my team out on the field for the first time today, and like baseball, these markets cannot function without clear rules and a ref to call balls and strikes.

The word is that ISPs want us to live in one where there is no referee and where there are no rules. The game only ends when the other team and all the fans go home because they are just sick of watching one team playing by their own rules.

I don't want to live in that world, and neither do the American people.

[The prepared statement of Mr. Doyle follows:]

PREPARED STATEMENT OF HON. MICHAEL F. DOYLE

Thank you Madam Chairman for holding this hearing, and thank you to the witnesses for appearing before us. I'd like to thank Matt Wood, a proud Pittsburgher, for being here in particular.

This subcommittee is once again discussing net neutrality and the fallout from Chairman Pai's repeal of the 2015 Open Internet Order. This short-sighted act has created an uncertain landscape where innovators and entrepreneurs trying to develop new services, applications, and devices can be taxed, tolled, or blocked at any time by an Internet Service Provider or ISP.

Prioritization practices that once were required to meet the standard of "reasonable network management," as judged by Federal experts in network engineering, telecommunications, and competition policy at the FCC, will now be determined by an ISP's bottom line.

As I have talked to companies large and small that developed and deployed new applications in the wake of the 2015 net neutrality rules, their message was clear: that the certainty created by the rules was stoking investment and giving certainty to investors, and that consumers were benefiting from these new offerings. A number of companies I talked with were working to deploy services that directly com-

peted with ISPs' own offerings at lower prices, bringing what we can all agree is much-needed competition to a stagnant marketplace.

I am deeply concerned that as we move forward in a world without the Open Internet Rules, ISPs will once again act in anticompetitive ways intended to tamp down competition and consolidate their hold over their customers. We've already seen ISPs zero-rate data from their own services and their affiliates—while forcing users to either limit usage on competing apps or pay costly overage fees.

If we look at the history of the internet before net neutrality, we find a number of instances where ISPs used their market position to stifle innovation and prevent competitors from bringing new products to market—all while coming to Congress and the Government arguing that they were only thinking about the consumer. Today we are adding another chapter to that book.

Today, we're talking about the prioritization of Internet content. If the testimony of a number of our witnesses is to be believed, paid prioritization can bring great benefits to the Internet. They claim that the coming flood of data can only be dealt with by prioritizing it and creating incentives and opportunities for Web sites and edge providers to pay to get their packets to consumers before their competitors.

Frankly, I don't believe it. We've heard these arguments before. The truth is that giving ISPs the ability to play gatekeeper only benefits the ISPs and their share-holders—and significantly HURTS innovators and consumers. More than that it fundamentally undercuts the level playing field and open marketplace that defines the Internet economy.

Now I have a bill that has 160 cosponsors in the House and companion legislation with bipartisan support in the Senate. To fix this mess. Our CRA would reinstate the 2015 Open Internet Rules and restore the FCC to its expert oversight role over ISPs network practices. When you look at the polling on this issue, these rules have overwhelming bipartisan support with the vast majority of Democrats, Republicans, and Independents. I hope to work with my friends on the other side of the aisle to make our bill bipartisan as well.

Madame Chairman, I'd also like to raise a process issue leading up to today's hearing. Mr. Bennett—who was the first to submit his testimony—amended his submission yesterday afternoon in meaningful ways. I'm concerned that many of the changes to Mr. Bennett's written submission were of a substantive and factual nature. What's more, the committee cannot get in the practice of allowing such last-minute changes. When witnesses play games like this it undermines the credibility of these proceedings.

I'd also like to note that baseball season is starting here again in Congress, and I had my team out of the field for the first time today. Like baseball, these markets cannot function without clear rules and a ref to call balls and strikes. The world that ISPs want us to live in is one where there is no ref and there are no rules. The game only ends when the other team and all the fans go home because they are sick of watching one team play by their own rules. I don't want to live in that world, and neither do the American people.

Mr. DOYLE. Madam Chair, I'd like to ask unanimous consent to have the following documents into the record: letters from INCOMPAS, the American Academy of Pediatrics, the National Association of Realtors, and the Center for Connected Health Policy.

Mrs. BLACKBURN. Without objection.

[The information appears at the conclusion of the hearing.]

Mr. DOYLE. Thank you very much, and I yield back.

Mrs. BLACKBURN. The gentleman yields back.

The chairman of the full committee, Mr. Walden, you're recognized for 5 minutes.

OPENING STATEMENT OF HON. GREG WALDEN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OREGON

Mr. WALDEN. I thank the chairman.

Thank you all for being here. We appreciate your expert testimony as we try to wade into this issue and get to the facts.

This subcommittee in particular has long led the way in exercising oversight over the internet. As we will hear today, the inter-

net looks nothing like it did when it was first fully commercialized back in 1995.

Back then, networks were in their nascent stage and network management presented a different set of problems. But today, with users sending over a hundred exabytes of data per month, networks have had to continually adapt to manage congestion and will need to do so even more adeptly and efficiently in the future.

The development of these networks and their ability to handle the ever-growing traffic demands users place on them is truly an innovative feat and not one that consumers often think about because, when you turn on your computer or unlock your phone, the network—the internet just works.

Because it appears so simple, it's easy for consumers to think about the internet connections being managed by their ISP—their internet service provider—from one end to the other, and for years consumers were told the internet was an information super-highway, giving the false impression that all internet traffic is moving the same direction on an equal plane at the same time.

We even use the word "traffic" to describe the movement of information and data across the internet, but it's actually a lot more complicated than that.

The internet is not a highway, where there can be so-called fast and slow lanes. The internet is actually a network of networks with many layers managing the data that flows across it.

There are applications layers that establish the connection and encrypt data. There is the transport layer that prepares data for transport. And there is the network layer which identifies the packet routing sequence.

Within these layers there are many different players aside from your ISP involved in managing traffic. Devices, software, Wi-Fi routers, and content delivery networks, or CDNs, can all load, manage, and relay traffic in different ways.

We will hear from our witnesses today a more in-depth explanation of how the internet actually works, not just talking points, and the role prioritization plays in operating networks.

But in a basic sense, prioritization has nothing to do with traffic speed. Rather, it's putting certain bits over others to ensure that all packets arrive to their destination on time.

A complete ban on prioritization would not permit this and would not allow some services and applications to operate smoothly. In other words, prioritization currently exists across the internet architecture and is necessary to ensure the internet functions properly.

It's also worth noting that, while we have heard a lot from our friends at the edge providers about how prioritization is bad for business, those operating at the edge pay to prioritize traffic every day through the use of various interconnection agreements, including CDN.

In order to facilitate high-demand applications like video streaming, many of the most popular content providers don't send data over the public internet. Rather, they directly interconnect with the CDN, allowing the edge providers' traffic to be prioritized to provide a better user experience. It's estimated that, by 2021, CDNs will carry 71 percent of global internet traffic.

Today is not the first time this committee has considered how to best legislate the issue of prioritization. I released draft legislation last Congress that would establish rules of the road to ensure the internet remains open to all.

Similarly, Chairman Blackburn introduced her Open Internet Preservation Act at the end of last year. Rather than waste our efforts on partisan legislation like the CRA, we hope our colleagues on both sides of the aisle will join our effort to development legislation that will provide lasting solutions to some of the outstanding questions regarding internet traffic management.

What exactly do we mean and what harms are we trying to address in restricting internet prioritization, whether paid or unpaid, whether the content's affiliated or not?

So I agree with Chairman Blackburn that, in order to move forward toward a long overdue legislative solution, we need to be able to have this conversation in a nuanced, in-depth manner and figure out a common ground.

So I look forward to hearing from all the witnesses. I would just tell you we have another hearing going on downstairs, so a lot of Members have to bounce back and forth. But we do have your prepared testimony, and we appreciate your participation in this very important discussion about the future of the internet.

[The prepared statement of Mr. Walden follows:]

PREPARED STATEMENT OF HON. GREG WALDEN

Good morning, and welcome to our witnesses.

The Energy and Commerce Committee has the broadest jurisdiction in all of Congress. And that jurisdiction includes one of the most important social and economic tools in the history of the world—the internet.

This subcommittee in particular has long led the way in exercising oversight over the internet.

As we will hear today, the internet looks nothing like it did when it was first fully commercialized in 1995. Back then, networks were in their nascent stage and network management presented a different set of problems. But today, with users sending over 100 exabytes of data per month, networks have had to continually adapt to manage congestion, and will need to do so even more adeptly and efficiently in the future.

The development of these networks, and their ability to handle the ever-growing traffic demands users place on them is truly an innovative feat. And not one that consumers often think about—because when you turn on your computer, or unlock your phone, the internet just works.

Because it appears so simple, it is easy for consumers to think about their internet connection as being managed by their Internet Service Provider, or ISP, from end to end. And for years, consumers were told the internet was an 'information superhighway' giving the false impression that all internet traffic is moving the same direction on an equal plane at the same time. We even use the word 'traffic' to describe the movement of information and data across the internet—but it is actually a lot more complicated than that.

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But in a basic sense, prioritization has nothing to do with traffic speed, rather it is putting certain bits over others to ensure that all packets arrive to their destination on time.

A complete ban on prioritization would not permit this and would not allow some services and applications to operate smoothly. In other words, prioritization currently exists across the internet architecture and is necessary to ensure the internet functions properly.

It is also worth nothing, that while we've heard a lot from our friends at the edge providers about how prioritization is bad for business, those operating at the edge pay to prioritize traffic every day through the use of various interconnection agreements, including CDNs.

In order to facilitate high demand applications like video streaming, many of the most popular content providers don't send data over the public internet, rather they directly interconnect with a CDN, allowing the edge provider's traffic to be prioritized to provide a better user experience. It is estimated that by 2021, CDNs will carry 71% of global internet traffic.

Today is not the first time this committee has considered how to best legislate the issue of prioritization. I released draft legislation last Congress that would establish rules of the road to ensure the internet remains open to all. Similarly, Chairman Blackburn introduced her Open Internet Preservation Act at the end of last year.

Rather than waste our efforts on partisan legislation like the CRA, we hope our colleagues on both sides will join our effort to develop legislation that will provide lasting solutions to some of the outstanding questions regarding internet traffic management.

What exactly do we mean and what harms are we trying to address in restricting internet prioritization, whether paid or unpaid, whether the content is affiliated or not?

I completely agree with Chairman Blackburn that in order to move forward toward a long overdue legislative solution, we need to be able to have this conversation, in a nuanced, in-depth manner, and figure out the common ground.

I look forward to hearing from all of our witnesses.

Mr. WALDEN. With that, Madam Chair, I yield back the balance of my time.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Pallone, you're recognized for 5 minutes.

OPENING STATEMENT OF HON. FRANK PALLONE, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW JERSEY

Mr. PALLONE. Thank you, Madam Chair.

The internet is a powerful engine of economic growth and a potent platform for free speech. With a working broadband connection, anyone can work from home, sell their own products online, and connect with companies a world away.

And in the past few years, we have seen how the internet can help everyday people launch a worldwide political movement.

But the power of the internet is rooted in the principles of net neutrality. These principles are simple and well understood. Broadband companies cannot pick internet winners and losers by blocking or slowing down content or charging extra for fast lanes.

It's a question of fairness, and there are no loopholes. Until the Trump administration took over the FCC, even the broadband providers themselves supported these principles, including a flat ban on fast lanes.

The largest providers told us time and again that they agreed that paid prioritization should be prohibited. They said that they had no intention of charging anyone extra for faster speeds.

But recently those voices have gone silent, and that silence presents a real threat to small businesses and speech online. Where there was once agreement on a prohibition on fast lanes, some now want to add loopholes to net neutrality. The reasoning is con-

voluted and confusing. They argue that somehow allowing broadband providers to charge small companies extra for internet fast lanes is good for small business. But that makes no sense, and no one's buying it.

Small businesses oppose having to pay extra for fast lanes. So do telemedicine companies, disabled veterans groups, self-driving-car companies, churches, nonprofit, and the list goes on.

Net neutrality advocates have spoken loud and clear. We want everyone to have a faster internet, not just the chosen few who can afford to pay extra, and that's why Democrats on this committee introduced the LIFT America Act to bring faster broadband to everyone.

The only ones who want broadband providers to charge money for fast lanes are the broadband providers, and despite these latest attempts to muddy the water and create confusion, banning paid prioritization is not a new issue.

The FCC solved this problem when it passed net neutrality in 2015. At that time, the FCC correctly banned these fast lanes with the exception of certain specialized services like health care.

The FCC got it right in 2015 and the Trump FCC got it wrong when it killed net neutrality last year, and that's why I support the legislation introduced by Ranking Member Doyle that would restore the well-crafted and balanced 2015 protections, and I encourage any of my colleagues who support real net neutrality to sign on to Ranking Member Doyle's CRA as well.

The CRA is the best way to put net neutrality back in place and support small businesses, and I'd like to yield the remaining time to Ms. Eshoo.

[The prepared statement of Mr. Pallone follows:]

PREPARED STATEMENT OF HON. FRANK PALLONE, JR.

The internet is a powerful engine of economic growth and a potent platform for free speech. With a working broadband connection, anyone can work from home, sell their own products online, and connect with companies a world away. And in the past few years, we have seen how the internet can help everyday people launch a worldwide political movement.

But the power of the internet is rooted in the principles of net neutrality. These principles are simple and well understood: broadband companies cannot pick internet winners and losers by blocking, or slowing down content or charging extra for fast lanes. It's a question of fairness, and there are no loopholes.

Until the Trump administration took over the FCC, even the broadband providers themselves supported these principles, including a flat ban on fast lanes. The largest providers told us time and again that they agreed that paid prioritization should be prohibited. They said that they had no intention of charging anyone extra for faster speeds. But recently, those voices have gone silent, and that silence presents a real threat to small businesses and speech online.

Where there was once agreement on a prohibition on fast lanes, some now want to add loopholes to net neutrality. The reasoning is convoluted and confusing-they argue that somehow allowing broadband providers to charge small companies extra for internet fast lanes is good for small business.

This makes no sense and no one is buying it.

Small businesses oppose having to pay extra for fast lanes. So do telemedicine companies, disabled veterans groups, self-driving car companies, churches, non-profits, and the list goes on.

Net neutrality advocates have spoken loud and clear: we want everyone to have a faster internet, not just the chosen few who can afford to pay extra. That's why Democrats on this committee introduced the LIFT America Act to bring faster broadband to everyone.

The only ones who want broadband providers to charge more for fast lanes are the broadband providers.

Despite these latest attempts to muddy the water and create confusion, banning paid prioritization is not a new issue.

The FCC solved this problem when it passed net neutrality in 2015. At that time, the FCC correctly banned these fast lanes, with the exception of certain specialized services like healthcare. The FCC got it right in 2015 and the Trump FCC got it wrong when it killed net neutrality last year.

That's why I support the legislation introduced by Ranking Member Doyle that would restore the well-crafted and balanced 2015 protections. And I encourage any of my colleagues who support real net neutrality to sign on to Ranking Member Doyle's CRA as well. This CRA is the best way to put net neutrality back in place and support small businesses.

Thank you.

Ms. ESHOO. I thank our ranking member, and good morning, everyone. And to the witnesses: Welcome, and thank you for being here.

We are now a decade into the fight to protect net neutrality, and throughout that time there have been many arguments from those who oppose it: that it will kill jobs, it would harm investment, or hurt the free press.

All of these have been refuted each in turn. This is actually, I think, a very simple issue. It's about fairness and equal access to an essential resource, the internet.

The 2015 Open Internet Order created the strongest, most reliable rules to protect that level playing field for innovation. The courts and the FCC both acknowledged that net neutrality was critical to the virtuous cycle that has enabled the internet to act as a tool of growth, of innovation, of investment, and of free expression.

That same FCC found that paid prioritization is inherently harmful to that fruitful cycle that fuels education, jobs, and our economy.

Yet now we have the same companies who proclaim in full-page newspaper ads that they support net neutrality, but they are pushing for an exception for prioritization.

This is about money. This is about money. We should just all acknowledge that and have a debate about it. But it's all about money.

We may be a decade down the road, but it's about the same thing that it always has been about, and that is who controls the onramps to the internet, being able to pick winners or losers, and that's based on pay to play. It is about money.

I don't blame companies for wanting to make money. That's what they are in the business to do. But we have an obligation to the public, and I think that's what this debate is about.

So I look forward to hearing from the witnesses, and I think everyone knows exactly where I stand on this.

[Laughter.]

Ms. ESHOO. I yield back. Thank you.

Mrs. BLACKBURN. The gentlelady yields back. Mr. Pallone yields back, and this concludes our Member opening statements.

I will remind the committee that each Member's opening statement will be made a part of the permanent record for the committee.

We thank our witnesses for being here today, and you all are going to have the opportunity to give your opening statements, followed by a round of questions from our Members.

Our panel today: Mr. Richard Bennett, founder of High Tech Forum; Mr. Peter "*Ree*-sa-vay"—am I saying that properly?

Mr. RYSAVY. "Ri-*sah*-vy."

Mrs. BLACKBURN. Rysavy, president of Rysavy Research; Mr. Paul Schroeder, director of public policy and strategic alliances at Aira Tech Corporation; and Matt Wood, policy director at Free Press.

We appreciate each of you for being here today and for providing your testimony.

Mr. Bennett, we begin with you. Please, each one of you as you speak, turn your microphones on. And, Mr. Bennett, you are recognized for 5 minutes for an opening statement.

STATEMENTS OF RICHARD BENNETT, FOUNDER, HIGH TECH FORUM; PETER RYSAVY, PRESIDENT, RYSAVY RESEARCH; PAUL W. SCHROEDER, DIRECTOR, PUBLIC POLICY AND STRATEGIC ALLIANCES, AIRA TECH CORPORATION; MAT-THEW F. WOOD, POLICY DIRECTOR, FREE PRESS AND THE FREE PRESS ACTION FUND

STATEMENT OF RICHARD BENNETT

Mr. BENNETT. Good morning, Chairman Blackburn, and hello to Chairman Walden, Ranking Member Doyle, and Ranking Member Pallone, and members of the committee, especially Ms. Eshoo, whose district I used to live in and who gave me a really hard time the first time I testified before this committee, but I probably deserved it.

Prioritization has been part of the internet's design from the beginning in that there is a type of service field in the internet protocol header, and it's been refined through integrated services, a standard design in the 1990s, then differentiated services, so there is not by itself anything controversial about prioritization.

And I think it's fair to say that, while it was controversial for a time, it's come to be recognized there is a consensus sort of support that, done correctly, prioritization is beneficial to applications.

So we have reached this consensus, I think, after about 15 years of debate around what we call net neutrality now, that it's legitimate for ISPs, CDNs, transit networks, and purpose-built networks like WebEx to accelerate time-sensitive traffic.

If you go back to the original paper that Chairman Wheeler wrote on net neutrality, he points out that the internet is inherently biased against real-time applications as a class and biased in favor of content applications, and I think if we are not careful about how we treat paid prioritization we can make that bias worse, and that's something we should try to avoid.

I think we also—going back to the consensus question—we also believe that competition is a good thing. We want tech policies that increase that.

So prioritization and the related technologies such as resource reservation, traffic shaping, and dynamic path selection have not

only become commonplace, but I think they are widely regarded as essential to certainly the real-time applications part of the internet.

And this is good, because no matter how much capacity networks have, we can also always make their operation more efficient if we apply optimization techniques. There are certain problems that we solve without optimization that you can't really build your way out of simply by throwing more capacity at the problem.

It's like trying to solve, you know, throwing money at problems that you don't really understand.

And I think we appreciate that prioritization mechanisms such as the IEEE 802.11(e) standard that I helped design are beneficial to real-time applications such as voice in the same way that LTE bearers are.

The fact that one is provided free on a closed enterprise network and the other is sold as part of a bundle that includes carrier grade voice I think doesn't really impact on their utility. These are useful things. We found that, by prioritizing voice and Wi-Fi, we get four times as many voice calls through a Wi-Fi network.

But it's hard to explain the continual increases in broadband speed we have seen in the U.S. over the last 10 years—speed improves 35 percent per year—without giving some credit to the expectation of profit.

The fact that web speeds have stagnated over this same period, even declining in 2016, suggests something is wrong with the web's financial model, and I think you, the committee, explored that last week.

But leaving the consumer broadband market questions aside, paid prioritization internet optimization is very important to enterprises that have to connect, say, branch offices to headquarters.

The traditional way to do that was to lease—and in some cases still is widely done—people lease business data services lines like a T1 for $300 a month, and it only gives you 1.5 megabits per second.

But with prioritization, you could actually—with the proper management, you could actually use a public common internet connection to connect the branch office to the headquarters.

And so now you're getting 50 to 250 megabits per second for less than $100 a month. But this only works—you can only have that cost savings if someone is prioritizing the traffic on that pipe.

So let's bear in mind that, while there are fees for these things, the alternatives can also be quite costly.

So it's important, I think, to recognize the internet is no longer just a research network. The internet is *the* network. It has replaced all the other—I mean, not quite completely, but in the next few years, all the other networks are going to be subsumed by the internet.

So we can't apply the sort of, oh, like, research network standards to the internet. We have to recognize that the fundamental requirement is that it serves all the needs of all the used cases of all the people who connect to it.

And I think whatever it takes to do that is fine, you know, given the proper oversight.

[The prepared statement of Mr. Bennett follows:]

HighTech FORUM

Hearing Before United States House of Representatives

Committee on Energy and Commerce

Subcommittee on Communications and Technology

April 17, 2018

Testimony of Richard Bennett

Founder, High Tech Forum

Summary[1]

The Internet has undergone substantial change since it was initially designed in the 1970s. A network built to allow academics to use remote computers is now open to the public. The Internet has disrupted a plethora of major industries, and it has in turn been disrupted by advances in networking technology and applications. The backbone-oriented, end-to-end architecture of the research Internet has given way to today's Content Delivery Network (CDN) model. Large firms such as Google, Amazon, and Netflix have gained control over their network traffic by playing the roles of both network and application.

The traditional regulatory model that separated content from communications no longer fits; large content interests own worldwide networking facilities, only connecting to

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[1] This is a lightly edited version of comments filed on April 13, 2018; most changes are for clarity and style.

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Internet Service Providers (ISPs) to perform the relatively simple task of delivering streams of Internet packets over the last mile.

Regulators have struggled to keep up with the transformation of electronic communications from the telephone network to the Internet. While some infrastructure providers are highly regulated, others – such as Cloudflare and the pure CDNs – are almost completely free to behave as they please. While net neutrality once promised regulators a short-cut around the complexity of traditional competition law and economics, it has become all but impossible to reach consensus on its most troubling part, the presumptive ban on "paid prioritization" introduced in the FCC's 2015 Open Internet Order.

The naïve view of the Internet as a magically self-organizing system, enabling all applications to utilize the resources they desire without active engagement by network operators, has not proved out in the real world. While the web is still a dominant application, the Internet continues to spawn novel applications and better ways of enabling traditional ones with less expense and greater reliability.

A diverse pool of users and applications competes for access to critical network resources such as bandwidth, latency, packet loss, and jitter. This competition is central to the Internet's packet switching design and is therefore unavoidable. ISPs – both fixed-line and mobile – distinguish themselves largely in their expertise at managing network resources in optimal ways that meet consumer expectations.

Contrary to popular misconception, optimizations that improve the experience of users of real-time applications need not perceptibly degrade traditional applications such as video streaming, the web, or email. This is because traditional applications have extremely high

tolerance for variations in packet stream delivery speed because they buffer. Internet optimization is therefore *not* a zero-sum game.

New networking product lines such as Wide Area Network (WAN) Edge Infrastructure, Software Defined Networking (SDN), and Managed Services overcome shortcomings in the Internet's design by enabling dynamic routing or path selection. These capabilities enable the Internet to replace costly private lines for many enterprise applications.

ISPs can do the best job of traffic optimization when they can identify the nature and requirements of individual packet streams. The most effective way to do this – while preserving privacy – is to allow application developers to register applications requiring special treatment, and even to pay for such treatment in some circumstances. If this is not allowed, ISPs, CDNs, and dominant firms will not face robust competition.

A tremendous amount of misinformation is afoot about the factors that determine the performance of web pages, much of it by well-meaning advocates. The reality is that the speed at which web pages load on US broadband networks is largely controlled by choices made by web page owners. While the average speed of US broadband networks has increased 35% per year for a decade, web performance has remained stagnant, even decreasing in 2016.

The interests of innovators are best served when they are able to purchase the network services they need without undertaking the breathtaking expense of building the networks of data centers owned by the five largest US firms. A generally permissive approach to the design and sale of innovative network services – with proper oversight by well-informed regulators – is the best way forward for the Internet.

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While net neutrality – and especially the ban on Internet optimization for a fee – has been held out to policy makers as a silver bullet that solves the problem of keeping the Internet on track, it is a false hope. In reality, nearly all forms of network optimization are good in come contexts and bad in others. Our regulators need to develop the wisdom to tell the difference.

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Doyle, and Members of the Committee,

Internet traffic management – short of blocking and throttling – has proven to be the

most difficult element of the network neutrality construct to commit to regulation. Net

neutrality emerged in the early part of the century as a potentially simple way to craft Internet

regulations that balanced efficiency and fairness, provided a short cut to enforcing provisions

against anti-competitive conduct, and encouraged infrastructure owners to invest in resource

upgrades. In practice, net neutrality regulations are anything but simple because broad bans on

behavior that can be either constructive or destructive depending on context are necessarily

riddled with exceptions, loopholes, and special circumstances. A brief summary of the FCC's

actions is instructive.

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The Original Idea of Net Neutrality

In the first articulation of net neutrality *per se*, Professor Tim Wu attempted to split the baby.[2] On the one hand, he allowed broadband Internet service providers (ISPs) to manage traffic as they saw fit for the applications they provided (such as voice and video), but on the other he insisted they manage their "Internet gateway" in a blindly nondiscriminatory manner:

> *...absent evidence of harm to the local network or the interests of other*
>
> *users, broadband carriers should not discriminate in how they treat traffic on*
>
> *their broadband network on the basis of inter-network criteria.[3]*

By way of illustration, Wu explained that users of resource-intensive applications such as online gaming should pay for sufficient resources to run these applications successfully; but he did not approve of ISPs levying tolls for the use of gaming apps or other classes of applications.

Wu regarded his approach as superior to "open access" regimes such as Title II broadband unbundling that did nothing to remedy the "Internet's greatest deviation from network neutrality...[the] favoritism of data applications, as a class, over latency-sensitive applications involving voice or video." Wu proposed to permit ISPs to actively manage Internet traffic as long as they didn't do so arbitrarily.

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[2] Tim Wu, "Network Neutrality, Broadband Discrimination," *Journal of Telecommunications and High Technology Law* 2 (2003): 141, https://doi.org/10.2139/ssrn.388863.
[3] Wu.

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FCC Policy Statements Preceding Regulation

FCC Chairman Michael Powell proposed a generally similar approach a year after Wu

presented his paper at a Silicon Flatirons conference in Boulder, Colorado. Also speaking in

Boulder, Powell proposed a bill of rights for Internet users that came to be known as the "Four

Freedoms of the Internet."[4] Like Wu, Powell insisted that ISPs have the power to actively

manage traffic, but went further in declaring that this right should only be limited by disclosure

and the ability of users to run the applications of their choice:

> *I recognize that network operators have a legitimate need to manage*
>
> *their networks and ensure a quality experience, thus reasonable limits*
>
> *sometimes must be placed in service contracts. Such restraints, however,*
>
> *should be clearly spelled out and should be as minimal as necessary.*[5]

In 2005, the Kevin Martin FCC endorsed a slightly modified version of the *Four Freedoms*

as the Internet Policy Statement, but refrained from issuing regulations.[6]

FCC Traffic Management Regulations

In 2010, the Genachowski FCC issued the Open Internet Order, America's first set of

direct regulations over ISP traffic management practices. This order banned "unreasonable

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[4] Michael K. Powell, "PRESERVING INTERNET FREEDOM: GUIDING PRINCIPLES FOR THE INDUSTRY" (Federal Communications Commission, February 8, 2004), https://apps.fcc.gov/edocs_public/attachmatch/DOC-243556A1.pdf.
[5] Powell.
[6] "FCC Adopts Policy Statement," Federal Communications Commission, August 5, 2005, https://apps.fcc.gov/edocs_public/attachmatch/FCC-05-151A1.pdf.

discrimination" and permitted the sale of "specialized services" as long as such services were

not used to access the Internet:[7]

> We recognize that broadband providers may offer other services over
>
> the same last-mile connections used to provide broadband service. These
>
> "specialized services" can benefit end users and spur investment, but they may
>
> also present risks to the open Internet. We will closely monitor specialized
>
> services and their effects on broadband service to ensure, through all available
>
> mechanisms, that they supplement but do not supplant the open Internet.

These services were considered to include enterprise VoIP and similar applications that

did not touch the web.

In 2015, the Wheeler FCC strengthened the presumption against "paid prioritization" in

order to ban it:[8]

> A person engaged in the provision of broadband Internet access
>
> service, insofar as such person is so engaged, shall not engage in paid
>
> prioritization.

> "Paid prioritization" refers to the management of a broadband
>
> provider's network to directly or indirectly favor some traffic over other traffic,

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[7] Federal Communications Commission, "Report and Order: Preserving the Open Internet" (2010), http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1223/FCC-10-201A1.pdf.
[8] Federal Communications Commission, "Report and Order on Remand, Declaratory Ruling, and Order in the Matter of Protecting and Promoting the Open Internet" (FCC, February 26, 2015), https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-24A1.pdf.

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including through use of techniques such as traffic shaping, prioritization,

resource reservation, or other forms of preferential traffic management,

either (a) in exchange for consideration (monetary or otherwise) from a third

party, or (b) to benefit an affiliated entity.[9]

The Wheeler order substantially departed from the FCC's (by then) long-standing light-touch approach by banning practices that had been regarded as constructive (with some caveats) by previous commissions of both parties. On its face, the paid prioritization ban could make services that compete with carrier-provided Voice over LTE (VoLTE) unlawful because such services would need resource reservation (using the IETF's Integrated Services standard[10]) to be competitive, especially at higher definition.

Restoring Internet Freedom

The Pai FCC's 2017 *Restoring Internet Freedom Order* erased Wheeler's ban on paid prioritization:[11]

We also decline to adopt a ban on paid prioritization. The

transparency rule we adopt, along with enforcement of the antitrust and

consumer protection laws, addresses many of the concerns regarding paid

prioritization raised in this record. Thus, the incremental benefit of a ban on

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[9] Federal Communications Commission.

[10] R. Braden, D. Clark, and S. Shenker, "RFC 1633 - Integrated Services in the Internet Architecture: An Overview" June 1994, http://tools.ietf.org/rfc/rfc1633.txt.

[11] Federal Communications Commission, "Restoring Internet Freedom: Declaratory Ruling, Report and Order, and Order" (Federal Communications Commission, December 14, 2017), https://apps.fcc.gov/edocs_public/attachmatch/FCC-17-166A1.pdf.

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paid prioritization is likely to be small or zero. On the other hand, we expect

that eliminating the ban on paid prioritization will help spur innovation and

experimentation, encourage network investment, and better allocate the costs

of infrastructure, likely benefiting consumers and competition. Thus, the costs

(forgone benefits) of the ban are likely significant and outweigh any

incremental benefits of a ban on paid prioritization.[12]

As noted, the *Restoring Internet Freedom Order* required disclosure of paid prioritization

while permitting the practice. Thus, it is consistent with the *Four Freedoms.*

The history of FCC regulation of traffic management shows a general acceptance of

Internet optimization – even for a fee – with proper disclosure, apart from the 2015 order. But

even in the orders and statements that support the practice, we see significant variation in

presumptions and general reasoning. In part, this variation reflects differences in prevailing

technologies and practices; it also reflects varying degrees of technology awareness on the part

of Commission staff and leadership.

While all FCC Internet regulations have been forward-looking to some extent, it's fair to

say that the Wheeler order pays greater attention to historical policies and practices. It was

especially attentive to agency actions such as the Computer Inquiries dating back to the

1960s.[13] The Pai order is the only one to mention 5G; this technology is crucially important

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[12] Federal Communications Commission.

[13] "FCC Computer Inquiries," *Wikipedia*, September 26, 2017,
https://en.wikipedia.org/w/index.php?title=FCC_Computer_Inquiries&oldid=802553161. See also Tom Wheeler,
"Remarks of Tom Wheeler at Aspen Institute 2016 Communication Policy Conference" (Federal Communications
Commission, August 14, 2016).

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because it's the most likely path to more robust, facilities-based competition for residential

Internet services. Most observers agree that competition is a more effective means than

regulation for ensuring constructive organizational behavior.

Why Optimize the Internet?

The Internet has become the world's primary communication medium. As such, it is

called-upon to carry information for a variety of applications, such as:

- The well-known World Wide Web;

- Internet Protocol-based telephone calls[14] intersecting with the traditional telephone

  network;

- Large private networks intersecting with the public Internet at several points (the five

  largest US corporations maintain such networks);

- Private communications between offices of organizations that use the Internet for

  Wide-Area Network (WAN) connectivity in lieu of purchasing Business Data Services;

- Public safety communications between dispatchers and first responders;

- Real-time communications among Internet of Things (IoT) devices, gamers, or

  specialized applications such as air traffic control.

This wide range of usage patterns requires a great deal of agility. In fact, there is no

"one-size-fits-all" traffic management technique that efficiently meets the needs of all

applications. The only approach that has ever worked is to treat each application with a high

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[14] Whether over the Internet or on a private intra-domain (intra-network-providers) or inter-domain (cross-provider) basis.

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degree of sensitivity to its requirements. This is why Service Level Agreements (SLA) specifying

precise Quality of Service (QoS) parameters are the norm for commercial Internet service

agreements.[15]

The Internet is a Statistical System

Unlike the traditional telephone network, the Internet is a statistical system that shares

resources among a broad pool of applications. The telephone network ensures that each

portion of each phone call is delivered with the same fidelity, latency, and quality within the

limits of the communications medium (wire or radio), but this quality assurance extracts a high

price in terms of network efficiency. The telephone network divides resources into fixed

buckets or channels of capacity and then allocates one per call. Because it is sized for peak load,

under normal load most of the network's capacity goes to waste.

The cable television network uses similar design logic. It consists of a number of 6 MHz

radio frequency channels, each of which is statically assigned to a television channel, a voice

channel, or an Internet channel. A typical cable TV network once assigned a pair of channels for

Internet access, but now it will tend to assign 24 channels for downstream Internet and 2 for

upstream[16]. Channels carrying unwatched TV channels effectively go to waste.

The Internet Uses Packet Switching

The Internet uses a technology known as "packet switching" that allows multiple users

and applications to share a single very large communication channel. While a traditional

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[15] Network Quality of Service is measured in terms of data volume, latency (delay), jitter (variations in latency) and packet loss.

[16] Or even more channels, as this changes routinely as bandwidth requirements, and hence speeds to end users, increase.

network with 24 channels would permit 24 users to communicate in parallel, each would only be allowed to use $1/24^{th}$ of the network's design capacity.

Packet switching would allow the 24 to use the channel in series, one after another. Each user's packets would transit the network 24 times faster, but they would have to wait behind packets already in flight or waiting for transmission. When fewer than 24 users are active, they will be able to access more bandwidth on the packet switched network than they would on the traditional circuit-switched network. When all 24 are active, their ability to access bandwidth would be the same, but some would experience more delay (latency) than they would on the traditional network.

Packet switched networks are typically provisioned with sufficient capacity that most users experience high speeds most of the time[17]. The packet switching design is efficient in terms of bandwidth allocation – it permits applications that need high bandwidth to obtain it – but they don't provide the same consistency of delay as circuit switching arrangements.

Packet switching was determined to be the preferred technology for computer applications as early as the 1960s because of its ability to provide flexible service. Computers run applications, and applications have a variety of different communications requirements. Hence, a flexible network tends to serve their interests better than network designed to support a single application such as telephone calls or TV viewing.

Hence, the Internet does two things that previous networks did not do:

1) It allows multiple users to dynamically share common network facilities; and:

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[17] This is largely proven out by results recorded for ISPs since 2010 by the FCC's "Measuring Broadband America" program.

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2) It allows applications to compete with each other for access to a common pool of

network resources such as bandwidth (capacity), delay (latency), jitter (variations in

latency) and packet loss.

This mode of operation raises issues with access to network resources that previous

technologies did not face, at least not to the same degree.

Resource Contention is Unavoidable on the Internet

The Internet is a system in which multiple users run a variety of applications over shared

infrastructure. Even when the last mile cable is unshared – as is the case for DSL and Ethernet –

the rest of the system, after that brief first hop link, is shared. Overall, the Internet consists of

several levels of traffic aggregation and disaggregation. Sharing is inherent in the Internet's

design.

Access to shared resources of any kind implies the development and implementation of

a sharing policy. For the Internet, this policy can take various forms, each of which has varying

degrees of Quality of Service impact on different applications:[18]

1. ISPs generally parcel bandwidth into service tiers that simply pre-allocate fractional

portions of total network bandwidth to each account. While a cable system may provide

one gigabit per second of bandwidth to a neighborhood, each subscriber is limited to

using their **subscribed quota** of 50, 100, or 250 Mbps, for example. While the total of

the subscriptions in a neighborhood will exceed actual capacity, network engineering

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[18] See a detailed examination of sharing policies in my paper: Richard Bennett, "Arrested Development: How Policy Failure Impairs Internet Progress" (Washington, D.C.: American Enterprise Institute, December 2015), http://www.aei.org/publication/arrested-development-how-policy-failure-impairs-internet-progress/.

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sensitive to usage patterns ensures that the expected speed is generally achieved by all active users. Some degree of over-subscription is essential to Internet economics, which depend on statistical multiplexing.

2. When networks are lightly used, operators may simply forward each packet of information on a **first-come, first-served** basis with no regard for its specific needs such as urgency or necessity. Because the Internet carries both "elastic" and "non-elastic" data[19], this policy is sub-optimal under most load conditions.

3. Operators commonly employ policies that seek to identify application types in order to apply **smart queueing policies** under moderately high load conditions. Voice packets have strict time requirements – less than 150 ms from end-to-end. But packets containing software code, such as patch updates, have very loose time requirements. Hence, it is sensible for operators to prioritize individual voice packets over software patches by **moving voice packets to the head of the transmission queue** feeding a moderately loaded data link. This practice does not impair the patch application because it doesn't alter the time at which its final packet arrives or it is not essential for the download to finish in a particular second of time, whereas the user of the voice application will soon audibly noticed any delays in that application. File transfer applications (of which the web is one) are not impacted by the delivery time of intermediate packets, only the final one. But each voice packet is impaired by delay.

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[19] Elastic data is buffered at the destination before use and is often stored, while non-elastic data is used immediately and then discarded. When packets of elastic data are lost, they are re-transmitted. When packets of non-elastic data are lost, the application simply moves on to the next packet in the stream.

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4. When network load increases from moderate to high, it becomes necessary for
    operators to discard data packets in order to maintain the efficiency of the Internet's
    Transmission Control Protocol (TCP). Because non-elastic applications don't use TCP,
    there is no value in dropping their packets. Operators have a number of choices for
    dropping TCP packets, such as dropping the newest, the oldest, or a random selection.
    They may also apply drop quotas to particular streams, especially very heavy ones. A
    common method is **Random Early Detection** (RED), an algorithm that discards packets
    at random but at a rate that corresponds to the degree of load on the network
    segment.[20] Classical RED is insensitive to Quality of Service, hence more sophisticated
    versions such as Weighted RED and Adaptive RED have been developed.[21]

    In more recent years, various forms of Active Queue Management (AQM) have been
    developed as well, such as CoDel (Controlled Delay) and Proportional Integral controller
    Enhanced (PIE) queueing. To overcome related problems, Google has also developed
    and deployed the new Quick UDP Internet Connections (QUIC) protocol, as an
    alternative to TCP flows for web-based and other Internet traffic.

5. Operators also commonly impose **quotas on the amounts of data** users are permitted
    to send or receive over a given period of time, especially when resource contention is
    high. Quota-based discard policies drop packets from heavy users before dropping those
    from light users. Alternatively, high load application streams – such as code downloads

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[20] S. Floyd and V. Jacobson, "Random Early Detection Gateways for Congestion Avoidance," *IEEE/ACM Transactions on Networking* 1, no. 4 (August 1993): 397–413, https://doi.org/10.1109/90.251892.

[21] Kevin Wallace, "Weighted Random Early Detection (WRED)," in *Cisco IP Telephony Flash Cards* (Cisco, 2005), http://www.ciscopress.com/articles/article.asp?p=352991&seqNum=8.

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that seek to saturate network capacity – would be subject to dropping before light load

streams, such as narrowband voice, that moderate their consumption of network

resources. Most Internet data today is video streaming, an application that regulates its

resource consumption[22].

We sometimes hear claims that network congestion can be eliminated by increasing the

capacity of data pipes to some arbitrary bandwidth. If this were the case, the research

literature on managing packet networks under load would not be so rich. In reality, building our

way out of network congestion is impossible because increases in the capacity of one part of

the Internet create more congestion in some other part.

It is also impossible to fully coordinate upgrades because the Internet is not simply a

single system managed by the single agent; it's a loose federation of networks that undergo

increases in load and capacity at their own rates.

Each time we add capacity to alleviate downstream congestion, we enable more

upstream congestion. So the battle for congestion-free networks is never-ending. This is

especially true for wireless networks.

Brief Overview of Internet Traffic Management

Some facially fair and uniform traffic management policies have been proved to be very

harmful to the Internet. The Internet consists of a mesh of Internet Exchanges in major cities,

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[22] Video servers do this using techniques such as Dynamic Adaptive Streaming over HTTP (DASH), where the server can dynamically – every few seconds - change between various quality levels to adapt to changing throughput conditions. Servers can adapt from SD quality when there is very little capacity to HD or 4K when there is an abundance. Servers also adapt to changes in their own CPU and storage resources due to load.

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Content Delivery Networks inside Internet Exchanges and ISP networks, middle mile facilities, and last mile networks.

Four Parts of the Internet

Figure 1: Four Parts of the Internet

Inside each of the four parts, we find Ethernet switches and Internet routers. The parts are interconnected by network circuits or "datalinks", which are typically wavelengths of light transmitted through fiber optic cables. Where datalinks meet routers, computer memories known as queues hold information packets awaiting transmission. The five resource management techniques described in the previous section apply to these queues.

The most simple, uniform management technique that can be applied to Internet queues simply drops new packets when the queue is full. The effect of this method – often

praised by net neutrality advocates[23] – is called "global Internet synchronization". Packet loss is a signal to TCP to slow down; when a series of application streams are told to slow down at the same time, the utilization of the datalink decreases from 100 percent to 50 percent.

Following this sudden decrease, the rate of TCP streams gradually increases until it reaches 100 percent again, and the process repeats. Because the Internet datalink is rarely at 100%, adding bandwidth is relatively costly and ineffective.

Techniques such as RED were developed to prevent synchronization. Because RED has unfortunate side effects on some applications, it has been supplemented and/or replaced with more advanced techniques such as CoDel, QUIC, and SPDY intended to ensure more efficient bandwidth utilization. This is an ongoing research area in computer science.

Optimization is Not a Zero Sum Game.

In the absence of perfect techniques to manage Internet contention, ISPs, transit networks, and both public and private CDNs differentiate traffic according to application type in order to optimize Quality of Experience. The Broadband Internet Technical Advisory Group (of which I am a member) published an excellent report on this topic in 2015, *Differentiated Treatment of Internet Traffic*.[24] The report demonstrates that traffic differentiation is not a zero-sum game due to the nature of Quality of Experience.

The BITAG report observes:

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[23] M. Chris Riley and Robb Topolski, "The Hidden Harms of Application Bias" (Free Press, November 2009), http://conference.freepress.net/sites/default/files/resources/The_Hidden_Harms_of_Application_Bias.pdf.
[24] Broadband Internet Technical Advisory Group, Inc., "Differentiated Treatment of Internet Traffic" (Boulder: BITAG, October 2015), http://www.bitag.org/documents/BITAG_-_Differentiated_Treatment_of_Internet_Traffic.pdf.

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Differentiated treatment can produce a net improvement in Quality

of Experience (QoE).

> *When differentiated treatment is applied with an awareness of the*
>
> *requirements for different types of traffic, it becomes possible to create a*
>
> *benefit without an offsetting loss. For example, some differentiation*
>
> *techniques improve the performance or quality of experience (QoE) for*
>
> *particular applications or classes of applications without negatively impacting*
>
> *the QoE for other applications or classes of applications. The use and*
>
> *development of these techniques has value.[25]*

This is especially true when large amounts of video streaming (Netflix, YouTube, Amazon Instant) traffic are present in a residential broadband network. Advocates who argue that it's impossible to prioritize one application without impairing another fail to examine prioritization in proper technical detail.

Internet applications interact with users at the level of transactions, each of which has a beginning, a middle, and an end. Downloading a web page is a transaction; watching a movie is a transaction, and making a Skype video call is a transaction.

Each transaction consists of a stream of packets, from a few in the case of an email to some number of millions in the case of some movies. When two Internet transactions take place on a residential Internet connection, their packet streams are intermingled. If we examine

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[25] Broadband Internet Technical Advisory Group, Inc., page iii.

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the Internet datalink, we might find clumps of a few hundred video packets interspersed with

an occasional Skype packet.

When several hundred video packets are enqueued for transmission inside an ISP

network when a Skype packet arrives, it is reasonable to move the Skype packet to the head of

the queue. This situation can arise because of the way video streaming services operate. They

are connected to ISP networks through very high-capacity datalinks, often 10 – 100 gigabits per

second. These datalinks are much faster than last mile datalinks connecting to consumer

premises.

They also tend to deliver traffic in an idiosyncratic matter, filling network queues as fast

as they can for short periods of time and then waiting before filling it again.

As the report explains:

Managing the impact of streaming video on other traffic

A typical video stream, as sent by a server, consists of a series of large

bursts of traffic, or "chunks," where each chunk consists of multiple packets

transmitted as quickly as possible. Sequential chunks are separated by time

periods that can span seconds. The transmission rate for each chunk is much

higher than the average rate of the encoded stream, which is a function of the

average chunk size and the time between chunks. The video client buffers the

chunks and then plays them out at the encoded rate.

When a chunk from a video stream arrives at a bottleneck link, it can

cause significant delay and jitter for other traffic sharing the same link,

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causing severe degradation in the QoE of time-sensitive applications such as interactive voice. This problem can be mitigated via a technique known as pacing, in which the video stream is differentiated and traffic shaped to a rate equal to or greater than the stream's average rate, but still lower than the bottleneck link's rate. Pacing spaces out the video packets in time, allowing other traffic in between the chunks and in doing so may reduce the latency and jitter experienced by other traffic. Since the first packet in each chunk is not delayed, the net effect of pacing on streaming video is to deliver video packets to the receiver at a more consistent rate without creating any additional delay in video playback. In effect, network pacing performs the same "smoothing" function in the received video content that the receive buffer in the video client would have performed had the chunks been received in discrete high speed bursts, so the QoE for the streaming video may be maintained because the content in each chunk is still received before the decoder needs it.

Pacing is an example of differentiated treatment that is implemented in mobile networks and that acts on the traffic within Internet access services. It may also be implemented by the sending service or application, reducing the need for differentiation in the network. As noted above, this technique can improve the QoE for other traffic without degrading the QoE for OTT video streams.

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Pacing replaces the stair-step traffic pattern with a line that more accurately represents

the average rate line. By introducing gaps into the clump of video packets, Internet

optimization in the form of pacing allows time-sensitive applications such as Skype to more

happily coexist with Netflix. Prioritizing Skype packets by moving them to the head of the

transmission queue does not impair Netflix because streaming is impacted more by the *volume*

of competing data than by its *placement*.

The following diagram from an academic paper illustrates the effect of pacing on a

typical video stream.

Figure 2: Rao et al., "Network Characteristics of Video Streaming Traffic".[26]

Thus, optimization in the form of prioritization is **not a zero-sum game** in which every

boost in queue position in favor of one application harms another application. In fact, this sort

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[26] Kenjiro Cho and Association for Computing Machinery, *Proceedings of the Seventh COnference on Emerging Networking EXperiments and Technologies* (New York, NY: ACM, 2011).

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of prioritization helps applications that need protection from the high-density, high capacity

packet streams associated with video servers and CDNs without producing a perceptible effect

on the video stream.

Software-Defined Networks

The Internet is a highly-connected mesh composed of a number of interconnected

networks. Between any given pair of Internet endpoints, a number paths exist by which the

endpoints can communicate with each other.

For example, a visit to the House of Representatives' website from my office in Colorado

travels directly from Denver to Washington through the Level 3 transit network, while one to

the Senate website goes from Denver to the Dallas Internet Exchange over the Comcast

network, where it is handed off to the AT&T transit network for delivery to an Akamai CDN

server in Chicago.

The standard way for the Internet to select paths uses the Border Gateway Protocol

(BGP). This is a system for exchanging routing information that was developed in the mid-90s to

facilitate the conversion of the Internet from a research network to a commercial one. BGP

allows networks to communicate with each other over a variety of intermediaries according to

business arrangements; it performs "policy-based routing".

BGP is sub-optimal because it selects paths mainly on distance rather than dynamic

criteria such as occupancy, packet loss, latency, jitter, throughput, historical reliability and

maximum peer capacity. Because some applications – especially real-time applications such as

voice and video conferencing – require consistent low latency, services have developed means

of overcoming BGP's shortcomings by continually assessing link quality and selecting optimal

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paths dynamically. While BGP provides static routing, the optimal approach provides dynamic

routing.

The pioneer of dynamic routing over the Internet was ITXC, a firm founded by Tom and

Mary Evslin in 1997.[27] ITXC delivered ordinary telephone calls on a wholesale basis using the

Internet as an intermediary between traditional telephone networks. Its method consisted of

evaluating current link quality and selecting paths that could best meet the quality

requirements of telephony over the statistical Internet.[28]

The ITXC dynamic routing method is now the basis of an entire software defined wide-

area network (SD-WAN) industry segment known by the names "WAN Edge Infrastructure",

"Software Defined Networking (SDN)", "Virtualized customer premises equipment (vCPE)", and

Managed Network Services (MNS).

A recent Gartner Group report identifies 16 of more than 40 firms offering these

products.[29] Their general value proposition lies in allowing customers to save money by using

the Internet as a substitute for Business Data Services or private lines. Gartner reports that SD-

WANs may be deployed by organizations on a "DIY" basis as ITXC did; but they may also be

offered by network service providers, system integrators, or specialized Managed Service

Providers.

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[27] "ITXC Corporation," *Wikipedia*, March 7, 2015,
https://en.wikipedia.org/w/index.php?title=ITXC_Corporation&oldid=650311017.
[28] For an explanation of the ITXC method, see this video podcast: Richard Bennett, "Internet Pioneers
Discuss Network Architecture and Regulation," *High Tech Forum* (blog), August 16, 2017,
http://hightechforum.org/internet-pioneers-discuss-architecture-regulation/.
[29] Andrew Lerner and Neil Rickard, "Market Guide for WAN Edge Infrastructure," Gartner Reprint (Gartner
Group, March 23, 2017), https://www.gartner.com/doc/reprints?id=1-3X6W6KF&ct=170404&st=sb.

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In many cases, SD-WANs are hybrids of ordinary commercial Internet services with

managed services and even private lines. All of these networking facilities use Internet standard

protocols, TCP and IP, and equipment either similar to or identical with standard Internet

routers.

FWaaS: firewall as a service; LAN Sw.: LAN switch; SWGaaS: secure web gateway as a service; UC: unified communications; UCaaS: unified communications as a service; UTM: unified threat management; WAN Opt.: WAN optimization; WOaaS: WAN optimization as a service

Source: Gartner (March 2017)

Figure 3: The Transformation of the WAN Edge

If a firm has Cisco or Citrix routers on premise with some ports connected to an ordinary

ISP and others connected to managed services and still others connected to private wires,

where does the Internet end and the private network begin? The demarcation point, if there is

one, is somewhere inside the router; but the router has a single configuration that regards all

three ports simply as routes of particular quality to general destinations.

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First Responder Network Authority (FirstNet)

On October 18-19, 2017, I attended an R & D summit on Highly Mobile Deployable

Networks sponsored by the National Institute of Standards and Technology's Public Safety

Communications Research Program at the Commerce Department's Boulder (Colorado) Lab.

The summit covered ongoing research projects designed to increase the capacity of FirstNet to

meet the needs of first responders in the aftermath of disasters.

Of particular interest was NIST's Public Safety Communication Research (PSCR) division

deployable network testbed, a means of testing new products and applications in the

deployables space intended to aid first responders.[30] The deployables discussed are LTE-based

temporary facilities that connect to permanent LTE facilities provided by FirstNet and other LTE

carriers. FirstNet is an LTE network with extensive Quality, Pre-emption and Prioritization (QPP)

mechanisms to help ensure greater reliability for first responder communications across a wide

range of scenarios ranging from full backhaul to intermittent backhaul to no backhaul at all; if

paid prioritization were not permitted, FirstNet would not be lawful.

These are challenging problems. We identified the following gaps in current products

and research:[31]

- Lack of tools/analytics and standards to measure, model, and predict network coverage,

  capabilities, load, and reliability in real time to inform decision making for self-organized

  networks

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[30] "Deployables" are networks composed of drones, balloons, vehicle-mounted towers, and cell towers on wheels that can be used to stand up a temporary communications infrastructure until a more permanent one can be recreated.

[31] Emily Nunez, "Deployable Networks R&D Summit Highlights," Text, NIST, November 1, 2017, https://www.nist.gov/news-events/news/2017/11/deployable-networks-rd-summit-highlights.

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- Inability for deployables from different vendors / agencies to recognize and synchronize with each other (discovery problem)
- Need to determine when to rely on deployable resources vs. core resources
- Need to determine an architecture or process for data storage and processing at the edge to minimize backhaul reliance and to balance network load
- "ICAM on the fly" -- How to register with other non-federated Identity, Credential, and Access Management (ICAM) services (i.e., mutual aid)
- Common Services/ Standardization for Applications
- Need to optimize size, weight, power of deployable hardware for different tasks, agencies, and environments

In the limited backhaul scenarios we examined, we discovered a need to connect deployables to standard LTE networks until a genuine FirstNet backhaul could be restored. Because FirstNet relies heavily on QPP, it stands to reason that the presence of such features on standard LTE networks would also be useful.

Both previous and current research for FirstNet include a number of topics related to prioritization and Quality of Service that would be adversely affected by an over-broad ban on optimization:[32]

- Establishment and Modification of LTE Bearers with Specific QPP[33] Requirements
- Prioritization of Traffic across Backhaul with Limited Bandwidth or Congestion

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[32] "Annual Report Outlines Year of Progress Leading to Launch of FirstNet Network | First Responder Network Authority," accessed April 13, 2018, https://firstnet.gov/newsroom/blog/annual-report-outlines-year-progress-leading-launch-firstnet-network.

[33] Preston Kelley, "End-to-End Quality Priority and Pre-Emption," NIST, August 12, 2016, https://www.nist.gov/programs-projects/end-end-quality-priority-and-pre-emption.

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- Prioritization of Encrypted Traffic (e.g., mobile Virtual Private Network [mVPN])

- Prioritization of Traffic processed through In-Vehicle Routers

- Technologies and Methods for the Interface between Local Control and the Network QPP Systems

- Assessment of EPS Bearer[34] Capabilities to Prioritize Encrypted Traffic

FirstNet builds on the "bearer" capabilities inherent in LTE. Bearers are a concept that comes to

LTE from the Internet through the IETF Integrated Services (IntServ) standards. These standards

were developed in the 1990s to ease the convergence of voice and data on a single network,

the Internet.[35] While IntServ was relatively dormant for many years, it became a vital part of

the Internet with the advent of LTE. It would be shame not to recognize its importance.

Other Applications for Optimized Networking

As we complete the transition from the monopoly circuit-switched network of the past

to the privately owned, decentralized, dynamic, packet switched networks of and future, it's

important to bear in mind the fact that the Internet is becoming ubiquitous.

While the net neutrality controversy has encouraged policy makers to divide networking

between an "Internet segment" frozen to the status quo of the 1990s and a "not-the-Internet

segment" free to grow and evolve, this is an unwise separation. Our grandchildren will not

recognize any form of networking as "not the Internet". Even if we stipulate, *arguendo*, that the

traditional Internet was a "best-efforts" system that treated all packets the same, it does not

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[34] "LTE in WIRELESS: Bearers in LTE," accessed April 13, 2018,
http://lteinwireless.blogspot.com/2012/12/bearers-in-lte.html.
[35] Bennett, "Arrested Development."

follow that the future Internet should follow such a model. The traditional Internet was small, highly specialized research network, while the Internet of the future must be all things to all people because it will be the only game in town.

For example, a myriad of applications than once required private lines – such as high-definition video conferencing, wholesale voice transport, high volume transaction processing, video entertainment, and industrial process control applications – can now run over Internet facilities with proper support from network service providers.

Consequently, we should not divide network applications into those suitable for the standard Internet and those that require private networks for specialized treatment. Rather, we should ensure that the Internet is sufficiently robust to handle the needs of *all applications, all the time*.

Why Charge for Optimization?

Advocates of strict net neutrality with a far-reaching ban on what they call "paid prioritization" have to walk a very fine line to endorse "reasonable network management". One example of this reasoning is the blog post on today's hearing by Phillip Berenbroick, Senior Policy Counsel at Public Knowledge.[36] Berenbroick denounces prioritization as "inefficient and unnecessary from a traffic management standpoint," while also claiming "it makes sense for [some] services to work in real time, while email does not need to appear in your inbox instantaneously."

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[36] Phillip Berenbroick, "House Commerce Takes on Paid Prioritization, an Essential Tenet to the Open Internet," Public Knowledge, accessed April 13, 2018, https://www.publicknowledge.org/news-blog/blogs/house-commerce-takes-on-paid-prioritization-an-essential-tenet-to-the-open-internet.

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This is a curious juxtaposition.

The only way real time applications can leap-frog email is for network service providers, end user operating systems, or other network devices[37] to prioritize. Hence, prioritization is good whether provided by users, CDNs, or ISPs, and even when provided by ISPs in the form of for-fee CDN services. The issue seems to be the payment of fees rather than the act of prioritizing. So we have to examine the role that fees pay in network management.

Reasonable network management of the type permitted by the FCC's 2010 and 2015 Open Internet Orders requires two distinct operations: first, the ISP has to recognize the types of applications generating the packet streams it sees. This can sometimes be very simple: Skype packet streams consist of packets much shorter than most Internet packets, and they're very evenly spaced. When an ISP sees a series of three short packets at a constant interval, it's very likely that they represent some sort of Voice over IP application that should be prioritized. This is the case even if the packets are encrypted.[38]

Similarly, when an ISP sees three clumps of full size packets, each consisting of a few hundred packets separated by a common interval, there's a high probability that they represent a video stream, but there are caveats. At the beginning of a movie streaming transaction, senders are testing the subscriber's network capacity while also examining their own network for load conditions and the presence of the desired title at the desired resolution. This creates quite a bit of network chaos, so application identification may take as much as a minute.[39]

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[37] Such as a home router gateway device, an Ethernet switch, or a Wi-Fi Access Point (AP).

[38] "Very likely" does not mean certain; they could be sensor readings as well.

[39] Because most significant network events take place in thousandths or millionths of a second, a minute is a very large chunk of network time.

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Video streams are often embedded in web pages as ads these days, so it can also be tricky to distinguish a genuine movie or TV show from some advertising fluff on a web page. Online games also need special treatment, but they often begin by downloading a great deal of imagery that can appear to be video streaming at the network level.

So identifying applications and guessing their requirements can be difficult unless applications announce themselves and specify their requirements. Internet standards such as IntServ and DiffServ specify mechanisms for this sort of identification, but they're not always operational across internetwork boundaries. Wi-Fi also employs such mechanisms according to the IEEE 802.11e standard.[40]

In the case of Wi-Fi, applications announce themselves to the network access point by sending an "Admission Control" message informing it of their upper and lower bounds on latency and data volume. If the network has sufficient resources, it will reserve the required amount and allow the application to proceed. As the application runs, it is allowed to obtain high priority network access. When complete, it notifies the network so the resources can be recycled.

This negotiation requires a bit of policy – the network can only give high priority to a limited number of applications, and it must trust the application to use resources responsibly. So this procedure is generally carried out on private networks. When it is, experience shows

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[40] IEEE Computer Society et al., *IEEE Std 802.11e™-2005: IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems--Local and Metropolitan Area Networks--Specific Requirements. Part 11, Amendment 8, Part 11, Amendment 8,* (New York, NY: Institute of Electrical and Electronics Engineers, 2003), http://ieeexplore.ieee.org/servlet/opac?punumber=10328.

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that networks are capable of successfully carrying four times as many phone calls as they could carry when every packet stream has the same priority.[41]

Payment for priority treatment (whether by queue re-ordering, resource reservation, or traffic shaping) serves the same purpose on a commercial ISP network that our Admission Control message does on the enterprise network. It is impossible for a network to give all packets high priority on any network, just as all the children in Lake Wobegon cannot really be above average. Regardless of its capacity, the network has a limited supply of low priority (or low loss, or low jitter) transmissions per second. These can either be parceled out at random — as net neutrality supporters appear to demand — or according to some sort of plan, the accuracy of which is dubious unless requestors have incentives to only seek low latency when they need it. As net neutrality advocates correctly point out, if all packet streams are prioritized, none are.

The most straightforward way to align user incentives with network capacity is to charge a consideration — perhaps a small fee — for the privilege of jumping the queue over packets of unknown character. The consideration might involve a barter, a quota, or some other non-monetary form. One idea that was suggested nearly a decade ago at a policy panel in Washington called for a quota of low-delay packets per month, similar to the minutes of use once attached to cellular telephone services.[42]

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[41] This narrative is based on personal experience with creating the IEEE 802.11e standard while working at Sharp Labs and then implementing enterprise Wi-Fi products that carried it out at Trapeze Networks.

[42] Richard Bennett and Brett Glass, "Forum on Network Management" (ITIF Forum on Network Management, Washington, D.C, March 12, 2008), https://itif.org/events/2008/03/12/forum-network-management.

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The value to the user and to the network provider is that today's guesswork would be replaced with a more certain system in which users and developers would register applications requiring treatment with ISPs so the latter could handle them with great precision.

Net neutrality advocates are worried that payment for specialized treatment could lead to abuse. This fear can be allayed through disclosure requirements addressing the amount of special treatment sold. If ISPs are selling more special treatment than they can reasonably provide, or selling much, much less than their peers, the regulator will understandably have issues. In any case, the potential problems of financial abuse are better resolved by empirical analysis and ex-post enforcement than by pre-emptive emotional reactions.

What about Free Speech?

Arguments for banning Internet optimization generally rest on a faulty understanding of Internet performance.

Many advocates have insisted that allowing ISPs to sell optimized delivery services would mute the voices of non-profit advocates and impose barriers to startups. For example, Malkia Cyril warned that "fast lanes" and "slow lanes" are limits on speech:

> *Internet Service Providers want to break the internet into fast and slow*
>
> *lanes that sell public voice to the highest bidder. If we lose that vote, the most*
>
> *democratic communications platform the world has ever seen could become*

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more like cable TV, a fairly scary place that reproduces the economic gaps and

racial hierarchies of the offline world.[43]

Cyril's fears are based on a misinterpretation of a reality of Internet commerce.[44] While

it's true that users abandon web e-commerce sites that are slow to load, the key to a fast site

does not rest on buying speed from ISPs. My research on the relative speeds of broadband

networks and websites indicates that the websites generally use a small fraction of the speed

ISPs make available to them today.[45]

Broadband Speed vs. Web Speed

While broadband network speed has increased by an average of 35% per year for ten

years, web page load times have remained fairly stagnant.[46] In 2016, for example, web page

load times were worse than they were in 2015. The FCC's *Measuring Broadband America*

reports have consistently shown that ultra-fast broadband speeds do not make web pages load

faster than they do over 12 – 15 Mbps networks.[47]

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[43] Malkia Cyril, "Only Net Neutrality Can Protect the Internet from Becoming like TV: White, Middle-Class and Exclusive," the Guardian, February 26, 2015, http://www.theguardian.com/commentisfree/2015/feb/26/only-net-neutrality-can-protect-the-internet-from-becoming-like-tv-white-middle-class-and-exclusive.

[44] Rick Whittington, "Is A Slow Website Costing You Sales?," accessed April 10, 2018, https://www.rickwhittington.com/blog/is-a-slow-website-costing-you-sales/.

[45] Richard Bennett, "You Get What You Measure: Internet Performance Measurement as a Policy Tool" (American Enterprise Institute, November 2017), http://www.aei.org/publication/you-get-what-you-measure-internet-performance-measurement-as-a-policy-tool/.

[46] Web page performance measurement is not as precise as we would like it to be, so it's possible that the first screens of web pages load much faster than they used to.

[47] Early MBA reports reported this fact correctly, but those issued after the FCC redefined "broadband" to 25 Mbps have claimed a threshold value of 25 Mbps even though the underlying data have not changed; see FCC's Office of Engineering and Technology and Consumer and Governmental Affairs Bureau, "Measuring Broadband America," Measuring Broadband America (Washington, DC: Federal Communications Commission, 2016 2011), https://www.fcc.gov/general/measuring-broadband-america; FCC's Office of Engineering and Technology and Consumer and Governmental Affairs Bureau, "2012 Measuring Broadband America: July Report" (Washington, DC: Federal Communications Commission, July 2012), http://transition.fcc.gov/cgb/measuringbroadbandreport/2012/Measuring-Broadband-America.pdf; FCC's Office

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Putting a website in a "slow lane" would require the ISP to reduce the speed of the

service it offers to the user from its native speed – an average of 85 Mbps in the US – to a speed

less than 15 Mbps.[48] This would raise serious false advertising issues.

So there is clearly more to the speed at which web pages load than the service provided

by ISPs. Other factors include the size and complexity of web pages themselves, because pages

must be processed by browsers before they can be seen. Mozilla Firefox has proved that simply

re-arranging web page content can cut load time in half.[49] The reason for this is that ads are

slower to load than native content.

Content Delivery Networks (CDNs) such as Akamai, Amazon AWS, and Fastly also make

web pages load faster than they would from a single web server. In fact, speeding up websites

is the fundamental value proposition for CDNs. It's worth noting that very large companies

operate their own CDNs. Each of America's five largest companies by market cap – Apple,

Google, Facebook, Microsoft, and Amazon – operates its own CDN as well as its own large scale

IP network ("pipes").

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of Engineering and Technology and Consumer and Governmental Affairs Bureau, "2013 Measuring Broadband
America: February Report," Measuring Broadband America (Washington, DC: Federal Communications
Commission, February 2013), http://transition.fcc.gov/cgb/measuringbroadbandreport/2013/Measuring-
Broadband-America-feb-2013.pdf; FCC Office of Engineering and Technology and Consumer and Governmental
Affairs Bureau, "Measuring Broadband America - 2014," Measuring Broadband America (Washington, DC: Federal
Communications Commission, 2014), http://www.fcc.gov/reports/measuring-broadband-america-2014; FCC's
Office of Engineering and Technology, "Measuring Broadband America Fixed Report - 2015," Federal
Communications Commission, December 22, 2015, https://www.fcc.gov/reports-research/reports/measuring-
broadband-america/measuring-broadband-america-2015; FCC's Office of Engineering and Technology, "Measuring
Fixed Broadband Report - 2016," Federal Communications Commission, September 29, 2016,
https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-
report-2016.
    [48] "United States's Mobile and Broadband Internet Speeds," Speedtest Global Index, accessed April 10,
2018, http://www.speedtest.net/global-index/united-states#fixed.
    [49] Richard Bennett, "The Firefox Fast Lane," *High Tech Forum* (blog), December 21, 2017,
http://hightechforum.org/the-firefox-fast-lane/.

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Advertising also has a significant effect on the speed at which webpages load. Many ad networks – such as Google – rely on real-time auctions to sell ads, and these auctions sometimes take more time than they do at others. Web pages, especially commercial ones, tend to include tracking by a variety of parties (most commonly Google and Facebook) that requires the execution of code while the page is loading. Executing this code requires CPU resources in the user's computer; this is why pages load faster when we upgrade our laptops and mobile devices.[50]

Consequently, "fast lane" services worthy of the name would not consist of high-speed data pipes within ISP networks. Rather, they would be comprised of fast CDN web servers located close to ISP networks – or even inside them, as many are – and pages free of advertising, tracking, and auto-play videos.

Hence, advocates who insist that optimization must be banned in order to protect free speech have failed to analyze the issue correctly. And despite the absence of benefit to the web from optimization, the practice is extremely useful – and even necessary – to the host of non-web applications that exist on the Internet today and will exist tomorrow.

What about Innovation?

The great myth about innovation stresses the lone inventor cobbling together a better mousetrap in a dorm room. While this is sometimes the case, the majority of significant innovations and inventions are made by large firms and well-funded startups. Bell Labs, for

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[50] I recommend the use of the "Ghostery" plugin for seeing the impact of trackers on web page tracking and performance; see https://www.ghostery.com/

Testimony of Richard Bennett on Internet Optimization

example, created the integrated circuit, fiber-optic communications, the Unix operating system,

and the C programming language; the microprocessor was devised by Texas Instruments and

Intel Corporation; the Internet was designed by researchers funded by the US Department of

Defense; the Google search algorithm was developed by recipients of National Science

Foundation (NSF) grants working in a well-equipped Stanford University lab; and the SPDY and

QUIC protocols that enable web pages to load faster were devised by Google within the last six

years. While 2016 was a down year for investment in the entrepreneurial ecosystem, venture

capital flow for the year is estimated at $69.1 billion in the US alone.[51]

Consequently, the first question for potential innovations in the Internet ecosystem is

whether the necessary capabilities are available to entrepreneurs at any price. If an innovation

cannot be done on the networks of the day, it will obviously not be done.

The Internet has proved to have something of an affinity for consolidation. It has

spawned an effective duopoly of Google and Facebook in the advertising market, for example.

Similarly, single firms dominate the markets for search, Internet retail, social networking,

mobile apps marketplaces, desktop operating systems, and video streaming.[52] The dominant

positions maintained by America's five most valuable companies – Apple, Facebook, Alphabet

(Google), Microsoft, and Amazon – are protected by the private content delivery networks

owned by each of these firms.

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[51] "After Peaking in 2015, Venture Investment Activity Normalizes in 2016, According to PitchBook," NVCA, accessed April 13, 2018, https://nvca.org/pressreleases/peaking-2015-venture-investment-activity-normalizes-2016-according-pitchbook-nvca-venture-monitor/.

[52] Richard Bennett, "Internet Monopoly Platform Crisis," *High Tech Forum* (blog), October 26, 2017, http://hightechforum.org/internet-monopoly-platform-crisis/.

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Facebook, for example has two billion users. A would-be competitor to this firm would need to reach similar scale because the value proposition of a social network is its ability to connect us to others. Hosting content and facilitating communication between two billion users requires enormous investment, outstripping the capacity of even our rich venture capital establishment. But would-be competitors may boot-strap their way to success by using commercial CDNs such as Akamai and Cloudflare, keeping costs in rough alignment with business growth and then gradually replacing CDN contracts with private investment, as Netflix did.

But the CDN model only works for applications that don't require real-time communication. Real-time applications such as voice and video conferencing rely on entirely separate networks – such as Cisco's Webex and the VoIP exchanges – that bypass the constraints of the public Internet. Real-time networks practice a form of admission control and strict internal management to guarantee low latency delivery across large portions of the planet.

Building networks of the size and scale of Webex is not practical for small entrepreneurs. And prices are high because there is limited competition for such services. A much more efficient technical and economic model would allow real-time startups to contract directly with ISPs for low-delay transport to ISP customers, in much the same way that firms purchase Business Data Services (BDS). But it's essential to allow entrepreneurs to reach potential customers who are not users of BDS. The public Internet is available to ordinary users at relatively low prices because the grade of service required by popular applications such as Netflix and Facebook is relatively low.

Testimony of Richard Bennett on Internet Optimization

Upgrading to higher quality services increases costs to ISPs. Ideally, these would be borne by users rather than startups. But it's extremely difficult to persuade users to upgrade to a higher service grade to run an application with which they have no experience. Consequently, it's sensible to allow third parties to purchase upgrades on behalf of potential customers so that they an appreciate the value of new services for gaming, video communication, augmented reality, virtual reality, and even holographic conferencing.

These applications are a poor fit to the service model of today's Internet, but they probably do represent the future of electronic communications. That future depends on regulators not strangling the baby in the cradle, however.

Conclusion and Recommendations

The "traditional" Internet as understood by policymakers (and many senior technologists no longer involved in day to day network engineering and operations) – an end-to-end system organized around a common backbone – is a thing of the past. Today's Internet is simply the universal network for all forms of electronic communication. Application service networks are often directly connected to last mile networks, and the role of transit and backbones has diminished, making old notions of "tier 1" and "tier 2" networks moot. To meet the new demands, the Internet has developed a new architecture consisting of content delivery networks, large private networks, parallel networks, and multiply-connected networks. Traditional protocols such as HTTP 1.1 and TCP have given way to SPDY/2 and QUIC, and traditional algorithms such as RED have given way to CoDel and PIE. The Internet is now entrusted with applications ranging from cat videos to safety-of-life first responder networks.

Testimony of Richard Bennett on Internet Optimization

Regulators must display wisdom by recognizing the new mandates and the new technologies. Trying to stuff the Internet back into the traditional mold is simply an exercise in futility. Internet Service Providers, innovators, regulators, and dominant (for the moment) service providers have always worked together according to the so-called "Internet model" of multi-stakeholder governance. This model has generally worked, and we should continue to rely on it.

Abandoning the multi-stakeholder model in favor of a top-down, micromanagement model assumes that regulators will be possessed not just of the wisdom born of experience but that they will indeed be endowed with god-like power to see far into the future. It's best for policy makers to limit the scope of regulatory power to the range of affairs that can be performed by mere human beings.

It's perfectly fine for regulators to permit first and sanction only in the presence of meaningful evidence of harm. The alternative stifles new technologies and applications before we've had the opportunity to test them. That is not the path to a better tomorrow.

Mrs. BLACKBURN. The gentleman yields back.

STATEMENT OF PETER RYSAVY

Mr. RYSAVY. Chairman Blackburn, Ranking Member Doyle, and other distinguished members of the subcommittee, thank you for the opportunity to testify at this important hearing.

I am president of Rysavy Research, an analyst in the wireless industry with more than 25 years of experience. When I started, the hot new wireless technology was 1G.

I am an expert in wireless technology. I've worked with many dozens of firms and have published more than 175 reports and articles. My testimony is on 5G.

5G will start to be deployed as early as this year—end of this year—and will become the dominant wireless technology through the 2020s. It is being designed and developed by organizations, individuals from all over the world, and will employ sophisticated mechanisms to handle different kinds of traffic flows.

This is critical because 5G is being designed to address a much wider range of use cases than prior generations of technology.

Many of the applications envisioned for 5G are of a control nature, and that means they need minimal delay and high reliability.

These types of applications, whether it's controlling drones in real time or robots or sending emergency messages to autonomous vehicles, will depend on traffic prioritization.

5G's reliance on traffic prioritization should not be viewed as problematic for internet traffic that will not be prioritized. Traffic differentiation and prioritization is not a zero sum game.

You can prioritize certain traffic flows without adversely affecting other users' applications. The goal in managing network traffic is to maximize the quality of experience across the entire subscriber base.

5G needs QoS management not only for traffic prioritization to support mission critical applications but also enable a fundamental architectural component called network slicing.

Again, 5G is being designed and developed for cellular operators to deploy on a global basis. Network slicing, implemented through virtualization, will allow an operator to provide different services with different performance characteristics customized for the specific use cases involved, such as those needing low latency enhanced reliability.

Even with new spectrum and expected peak throughputs that will exceed a gigabit per second, 5G networks will still have to manage latency, reliability, massive numbers of connections, and a mix of stationary and mobile users.

Capacity alone is not the solution. The United States has assumed global leadership in 4G. It enjoys deep LTE 4G penetration, leading smartphone platforms and the vibrant application ecosystem. But globally, countries and companies are investing in and concentrating on what will come next with 5G.

Constraining 5G with rules that restrict traffic management necessary for the traffic flows anticipated with 5G applications could threaten U.S. leadership in mobile technology and deployment.

Thank you.

[The prepared statement of Mr. Rysavy follows:]

Testimony of Peter Rysavy
President, Rysavy Research
Before the Subcommittee on Communications and Technology
Hearing on "From Core to Edge: Perspective on Internet Prioritization"
April 17, 2018

Chairman Blackburn, Ranking Member Doyle, and other distinguished Members of the Subcommittee, thank you for the opportunity to testify at this important hearing.

Introduction

My name is Peter Rysavy, and I am president of Rysavy Research, an analyst in the wireless industry with more than twenty-five years of experience. I am a leading expert in wireless technology, having worked with many dozens of firms and having published more than 175 reports and articles.

5G will employ sophisticated mechanisms to handle different kinds of traffic flows. This is critical because 5G will address a wider range of use cases than prior technology generations, such as 3G and 4G. Many of the applications envisioned for 5G are of a control nature, which means they need minimal delay and high reliability. These applications will therefore depend on traffic prioritization.

But 5G's reliance on traffic prioritization should not be viewed as problematic for Internet traffic that will not be prioritized. Traffic differentiation and prioritization is not a zero-sum game. Selective application of quality-of-service increases the quality of experience across the subscriber base.

5G needs QoS management, not only for traffic prioritization to support mission-critical applications, but also to enable a fundamental capability in its architecture: network slicing. Network slicing, implemented through virtualization, will allow an operator to provide different services with different performance characteristics to address specific use cases that require low latency and enhanced reliability.

Even with access to new spectrum and expected peak throughputs that will exceed 1 Gbps, 5G networks will be required to manage latency, reliability, massive numbers of connections, and a mix of stationary and mobile users.

The United States has assumed global leadership in 4G and enjoys deep LTE penetration, leading smartphone platforms, and a vibrant application ecosystem. But globally, countries and companies are investing in and concentrating on what will come next with 5G. Constraining 5G with rules that restrict traffic management necessary for the traffic flows anticipated with 5G applications could threaten US leadership in mobile technology and deployment.

Background Details

The millions of mobile applications already transforming the world are just the dawn of the next frontier in mobile broadband—humanity has barely begun exploiting the full potential of wireless technology. The Internet of Things, which will interconnect objects to increase their utility and efficiency, will account for tens of billions of new connections by next decade. IoT's potential is limited only by imagination; use cases

include self-driving cars with pre-crash sensing and mitigation, health biometric sensing and response, telemedicine, and proactive monitoring of critical physical infrastructure such as transmission lines.

What many of these new applications have in common are stringent data communication requirements, such as high reliability or minimal delay. This is true even for use cases without particularly onerous bandwidth demands. For example, a self-driving car or autonomous robot may need only a small amount of data, but it might have to receive that data within a few thousandths of a second. In contrast, a user watching a movie is not negatively affected if the video stream leaves the server a second earlier, with no interruption to the viewing experience.

How Quality-of-Service and Prioritization Work

Engineers have designed controls for how packets flow between base stations and users over the radio interface. Traffic-flow parameters include whether bit rates are guaranteed, their priority relative to other traffic flows, the maximum amount of packet delay that can be tolerated by the traffic in question, and the extent of permissible packet loss. LTE specifications define thirteen quality-class identifiers, each with unique parameters.[1] Voice over LTE (VoLTE), which is based on voice-over-IP protocols, uses these QoS mechanisms to provide carrier-grade voice service. Without this control, an LTE voice call would disintegrate if surrounding users were consuming large amounts of data—the network prioritizes voice as higher priority than data. The same prioritization of voice over data also happens in 2G and 3G networks.

Figure 1 shows how, in a QoS-enabled network, the network may schedule higher-urgency packets to transmit first, ahead of those with lower urgency.

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[1] For details about LTE QoS, refer to 3GPP TS 23.203. *Technical Specification Group Services and System Aspects; Policy and charging control architecture*, available at http://www.3gpp.org/DynaReport/23203.htm. Specifically, see Table 6.1.7, "Standardized QCI characteristics."

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Figure 1: Transmission of Packets According to Their Urgency in a QoS-Enabled Network

5G will employ similar, yet more sophisticated, mechanisms to handle different kinds of traffic flows. This is critical because engineers are designing 5G for a wider range of use cases than prior technology generations, such as 3G and 4G. As described below, 5G will employ a "network slicing" architecture that will depend heavily on QoS management. Many of the applications envisioned for 5G are of a control nature, which means they need minimal delay and high reliability.

Table 1 lists some typical applications and their QoS requirements.

Table 1: Examples of Applications and QoS Requirements

Application	Requirements
Speech	Guaranteed bit rate, low delay, but can tolerate some packet loss.
Internet of Things	Varying requirements depending on use case, but mission-critical applications will require low error rate and low delay.
Streaming (music, video)	High throughput, but can tolerate delay and some packet loss.
Health and medicine	Throughput-rate requirements vary. High priority for critical health applications.
Autonomous vehicles	High throughput and low delay, with low packet loss.
Video conferencing and telepresence	High average throughput, low delay, can tolerate some packet loss on video but less on voice.

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Application	Requirements
Operating system or application update	Can run in the background over an extended period, so QoS requirements are minimal.
Web browsing	High average throughput, low error rate, can tolerate slight delay.

Current wireless networks assign equal priority to all third-party application traffic, regardless of the application type. An analogy is a freeway on which fast-moving cars and slow-moving trucks use all lanes equally. The Information Technology & Innovation Foundation (ITIF) states in a report, "To date, we have been able to muddle through with this 'best-effort' system, but many of the exciting innovations around the corner will increasingly require reliable low-latency connections. And while some applications affirmatively need prioritization or some kind of differentiation, other applications can easily tolerate delay or jitter."[2]

The goal of intelligent traffic prioritization is to maximize the quality of experience across the largest number of users and application types possible, allocating higher priority for those applications that need it while not adversely affecting those that do not.

As ITIF states, "Traffic differentiation simply is not a zero-sum game." Because applications have varying quality requirements, selective application of QoS results in higher average quality of experience across the subscriber base. The Broadband Internet Technical Advisory Group agrees, stating, "For example, some differentiation techniques improve the Quality of Service (QoS) or Quality of Experience (QoE) for particular applications or classes of applications without negatively impacting the QoE for other applications or classes of applications."[3]

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[2] Information Technology & Innovation Foundation, *Crafting a Grand Bargain Alternative to Title II: Net Neutrality with Net Adoption*, October 2015. Available at http://www2.itif.org/2015-alternative-title-ii.pdf.

[3] Broadband Internet Technical Advisory Group, *Differentiated Treatment of Internet Traffic*, October 2015. Available at http://www.bitag.org/documents/BITAG_-_Differentiated_Treatment_of_Internet_Traffic.pdf.

> Differentiation is not a zero-sum game. Selective application of QoS increases the quality of experience across the subscriber base.

Figure 2 shows how a 5G wireless network could use QoS management to allocate different priorities to different traffic flows based on their urgency.

Figure 2: Radio Resource Management in a Wireless Network

5G (or LTE) Radio Channel, "Pipe," Carrying Multiple Traffic Flows

Higher-Priority Traffic Flows

Other Traffic Flows

Prioritized traffic:
- *Enables many new use cases*
- *Can be deployed to not adversely affect other users*

Rysavy Research

5G Use-Case Models Depend on Ability to Provide QoS

The International Telecommunication Union (ITU) is the organization charged with setting 5G objectives and approving final, technical standards for how 5G networks interface with one another and enabled devices. The ITU's recommendation M.2083-0[4] defines use cases using the following model.

Figure 3: ITU 5G Use-Case Model

Enhanced mobile broadband is faster Internet, a turbo-charged version of today's LTE-Advanced networks. "Massive machine type" refers to millions of sensors and controls placed throughout cities, homes, and businesses to improve energy efficiency, transportation, and other logistics. But it is the new ultra-reliable and low-latency category, also referred to as mission critical, that opens cellular networks to capabilities never before possible, such as advanced industry automation and autonomous vehicles. This category of 5G application will depend on the ability to deploy traffic prioritization.

Developers expect response times of less than a millisecond with 5G, ten times lower than with LTE, in which 10 msec latencies are typical. But unprioritized and competing with other traffic, the latency (round-trip time in the network) can be ten times higher, for example, 100 msec. At 60 miles per hour, a car travels nine feet in 100 msec versus only one inch in 1 msec. In a scenario of an intelligent highway warning a car of a pedestrian on the road at a blind curve, that could be the difference between life and death.

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[4] Available at http://www.itu.int/rec/R-REC-M.2083-0-201509-I

5G Networking Slicing and QoS Management

5G needs QoS management, not only for traffic prioritization to support mission-critical applications, but also to enable a fundamental capability in its architecture: network slicing. Network slicing, implemented through virtualization, will allow an operator to provide different services with different performance characteristics to address specific use cases. Each network slice operates as an independent, virtualized version of the network. For an application, the network slice is the only network it sees. The other slices, to which the customer is not subscribed, are invisible and inaccessible. The advantage of this architecture is that the operator can create slices that are fine-tuned for specific use cases. One slice could target autonomous vehicles, another enhanced mobile broadband, another low-throughput IoT sensors, and so on.

Figure 4 shows the network slicing architecture, with devices having access to only the slice(s) for which they have a subscription. Each slice has radio resources allocated, with specific QoS characteristics. Within the core network, virtualized core network functions support each slice and provide connections to external networks.

Figure 4: 5G Network Slicing Architecture

A recent report on network slicing from 5G Americas lists the following examples of slices: serving a utility company, servicing remote control for a factory, serving a virtual operator, and optimizing for streaming video.[5] Operators will be able to provision devices through account configuration so the devices can access specific slices. For consumers, one slice might be for best-effort, unprioritized Web browsing

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[5] 5G Americas, *Network Slicing for 5G Networks & Services*, November 2016. Available at: http://www.5gamericas.org/files/3214/7975/0104/5G_Americas_Network_Slicing_11.21_Final.pdf.

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while another slice could support prioritized telepresence that needs low latency and high bandwidth.

An example of an application using network slicing is a patient wearing body sensors that monitor a heart condition. The sensors continually report vital stats and GPS location to a medical application server, which in turn analyzes the data in real time, taking into account the patient's medications and medical history. Proper analysis depends on receiving accurate data regularly and without interruption—even if the network is congested because a half-dozen people are streaming video while on the same bus as the patient.

To support this application, the operator could provide a network slice customized for medical communications, perhaps one in which throughput rates are modest but the need for reliability and low-latency is high. In other words, the virtualized network that the medical application accesses via the network slice is optimized for the specific needs of health monitoring. In the event of a health event requiring treatment, detected either by the user's monitoring equipment or by the server using more sophisticated data analysis, the system advises the user to see a doctor. If the situation is critical, the monitoring equipment or server could summon an ambulance.

Figure 5: Medical Monitoring Example

Even with access to new spectrum and expected peak throughputs that will exceed 1 Gbps, 5G networks will be required to manage latency, reliability, massive numbers of connections, and a mix of stationary and mobile users. Fundamental to this task will be managing QoS. Different slices will have different QoS requirements, inherently

invoking traffic management within each slice. As the 5G Americas paper states, "Each slice is defined to meet different service/application requirements, which are represented in a certain QoS level. A QoS level can be defined by certain performance descriptors such as delay, jitter, packet loss and throughput." In addition, the amount of radio and network resources to apply to each slice, determined based on demand across all slices, will require QoS management.

Conclusion

The communications requirements of today's mobile network applications span a huge range. One application may need high throughput but can tolerate significant delay. Another may need to send only a small number of bits, but these must traverse the network with minimal delay. Future Internet of Things innovations, from intelligent highways to smart-grid monitoring, will only increase the rich variety of application diversity. QoS mechanisms in 4G, and those under development for 5G, provide for application developers and operators to specify needs and for the network to dynamically accommodate them.

Developers and operators have an incentive to enable a diverse range of services, and empowering them to optimize networks to meet competing needs will result in the highest possible quality of experience for the largest number of users. The business case for massive 5G investment can only be made by being able to support all potential applications.

The U.S. wireless industry is at a critical juncture. The United States has assumed global leadership in 4G and enjoys deep LTE penetration, leading smartphone platforms, and a vibrant application ecosystem. But globally, countries and companies are investing in and concentrating on what will come next with 5G. Constraining 5G with rules that unnecessarily undermine its potential would harm the United States' ability to lead the world in 5G technologies and deployment.

Sincerely,

Peter Rysavy, President, Rysavy Research
April 13, 2018

Mrs. BLACKBURN. The gentleman yields back.

Mr. Schroeder, you are recognized for 5 minutes, and I will give you a warning at 30 seconds. How's that?

STATEMENT OF PAUL W. SCHROEDER

Mr. SCHROEDER. Thank you very much. Good morning. I think the microphone is on.

Thank you, Chairman Blackburn, members of the subcommittee. Very pleased to be with you this morning. My name is Paul Schroeder, and I am here on behalf of Aira, a San Diego-based technology company.

Our groundbreaking service provides instant access to visual information for people who are blind or visually impaired. As such, our service relies on the transmission of streaming video from the network edge through mobile up to the internet without interruption at high speeds to ensure ultra-low latency connection between the blind individual and the remotely located sighted assistant who is providing information based on the video feed.

We leverage mobile communications as well as innovative technologies such as the smart glasses that I am wearing, and yes, there is a camera in the middle of these glasses that is connected to an agent as we speak. We also use GPS and other sensors, augmented reality, and are incorporating machine learning.

Besides the technology, Aira's success really depends on our human agents. They are highly trained, they are paid, they are held to a confidentiality requirement, and they do undergo background checks before they serve as an agent.

Our customers—we call them explorers—pay for access to a fixed number of minutes per month. We are, though, working with agencies such as the Department of Veterans Affairs to ensure that blind veterans have access to this critical service.

I also want to note that Congressman Peters and Congressman Rutherford have been very helpful in leading a bipartisan effort to ensure that the VA is paying attention to these new technologies.

This week, Aira has designated the congressional office buildings as free Aira zones. This was a choice we made because there is a large group of individuals who are blind visiting this week, and we know that this will help them navigate the halls of Congress more effectively.

We encourage others to do this, and I do want to note for Chairman Blackburn, your home State airport of Memphis was the first one to join the Aira Airport Network, paying for the minutes of Aira users at Memphis airport in order to get around the airports more effectively.

Yesterday, two of our Aira explorers ran the Boston Marathon using Aira. Now, most of us, blind or sighted, probably aren't going to run a marathon. But the test of a low-latency available network was put to the test at the marathon, and many of us will have opportunities to test that in other environments, for example, hustling through an airport trying to find the gate for our airplane, checking out bus signs in a crowded bus garage to figure out the one that we need, quickly looking at a chart or slide in a meeting or a classroom, or maybe a congressional hearing, in order to get the information from that slide as a person who's blind, putting in-

formation into these kiosks that are popping up everywhere in order to order or confirm a reservation, and, of course, reading a medication label to ensure that we are actually taking the right medication.

For those of us who are blind or visually impaired using Aira, we need instant access to this information. We need a network that is reliable and a network that has low latency, because our video is able to stream upward from the mobile edge.

We are particularly pleased to note our partner AT&T has offered dynamic traffic management to Aira to ensure that our users have the low-latency network and reliable connectivity that they need and our agents need as well.

I am pleased to say this morning I am joined by an agent—Amy, are you there?

AGENT. I am. Good morning, Paul.

Mr. SCHROEDER. Oh, I left the speaker by the phone. Do you want to do a very quick description of the room, please?

AGENT. Absolutely. I see three rows of a desk and that have white wood on the bottom of them and then a darker mahogany on the top of the desk and they are separated by an aisle in the middle, and the very back of the room has a single panel of speakers. I see the chairwoman is in the very middle of the room. A gentleman to her left is waving at me.

[Laughter.]

AGENT. American flags that are flanking the center——

Mrs. BLACKBURN. Thirty seconds.

AGENT [continuing]. Three windows directly across——

Mr. SCHROEDER. I am going to have you hold up, and we'll come back to you if there's a question for the agent.

We are investing in artificial intelligence as well so that we can bring automation to our service, and we are, of course, looking forward to the emergence of 5G, which will help our low-latency network and service be even stronger.

Finally, I just want to say we encourage policymakers to support policies and programs that will promote and expand reliable access to visual information such as what Aira is providing as a right to those of us who are blind or visually impaired.

Thank you.

[The prepared statement of Mr. Schroeder follows:]

STATEMENT

Presented by Paul W Schroeder

Director, Public Policy and Strategic Alliances

Aira Tech Corp.

Before the

Committee on Energy and Commerce

Subcommittee on Communications and Technology

Hearing "From Core to Edge: Perspective on Prioritization. "

April 17, 2018

Summary

Aira provides people who are blind or low vision with instant access to visual and environmental information, whenever and wherever users request it. Aira leverages the power of mobile communications – together with innovative technologies (such as smart glasses, Augmented Reality, machine learning, geolocation, and sensors) and professionally-trained human agents.

Founded in San Diego in 2015, Aira has secured venture funding of over $15 million. The service was launched for consumer subscription in April 2017. Further information, including videos demonstrating Aira, can be found at our website https://www.aira.io.

As a cloud-based service, Aira relies on mobile communications networks as well as the Internet. Video and other sensor data is transmitted directly from the Aira user's smart glasses through a mobile network to an Aira agent's dashboard. As a cell-based service, Aira is widely available, but it requires a robust network with dependable connectivity. AT&T's Dynamic Traffic Management (DTM) ensures that our users have low latency and robust connectivity for the transmission of streaming video on which our agents rely to provide guidance and support.

Aira has invested in artificial intelligence to support automated services. We recently launched our new Horizon product with an AI-agent, "Hey Chloe™," and we will expand her capabilities. Aira looks forward to leveraging the capabilities of emerging 5G networks to support our vision of creating smart communities that enable a level playing field for people of all abilities.

We encourage policymakers and regulators to support policies and programs which promote and expand reliable access to visual information as a right for individuals who are blind or visually impaired.

Introduction

My name is Paul W. Schroeder and I serve as Director of Public Policy and Strategic Alliances for Aira Tech Corp. I am pleased to provide testimony which describes our groundbreaking service that provides unprecedented access to visual information for people with blindness or visual impairment. I lead our public-sector engagement as well as providing guidance regarding partnerships with agencies and organizations serving people with disabilities. Our service is relevant for this Subcommittee hearing because our service relies on the transmission of streaming video, without interruption, at sufficient upload speeds to ensure a low-latency connection between a blind individual and the remotely located sighted assistant who is providing information.

Aira develops transformative technology that provides greater information and independence to those with vision loss by connecting them immediately via streaming video to a network of professional Agents. The start-up is on a mission to provide people who are blind or low vision with instant access to visual and environmental information, whenever and wherever users request it. Aira provides this service by leveraging the power of mobile communications – together with innovative technologies (such as smart glasses, Augmented Reality, machine learning, geolocation, and sensors) and professionally trained human agents. Aira users, just by tapping a button on the Aira app, connect within seconds to a network of distributed, trained agents who help blind people gain immediate and unprecedented access to information and assistance in real time. Our agents are carefully screened, trained, and compensated for their work. They are also held to a strict confidentiality requirement and they undergo detailed background checks.

Founded in San Diego in 2015, Aira has secured venture funding of over $15 million. The service was launched for consumer subscription in April 2017.

Our customers (whom we call Explorers) use the service to pursue a variety of activities ranging from navigating busy city streets and airports, to reviewing printed material, catching public transportation, recognizing and interacting with colleagues in the workplace and classroom, obtaining real-time assistance at work and home, successfully completing job applications, shopping, pursuing recreation endeavors, and literally traveling the globe. Further information, including videos demonstrating Aira, can be found at our website https://www.aira.io.

Since launch, we have achieved significant milestones. Below are some service accomplishment metrics.

- 1 million minutes used

- 100,000 sessions initiated

- 25,000 work-related tasks completed

- 100 agents located across 30 states

- 1500 users ranging in age from 18 to 93 (51% men and 49% women)

- 100 college campuses offering scholarships covering a full school year of Aira service

- Free Aira assistance for all tasks and activities related to job-seeking and employment

Company Values

Suman Kanuganti, CEO and co-founder of Aira, articulated three core values that guide the company. They are based on the understanding that the real challenge with blindness isn't the loss of sight. It is the loss of immediate access to visual and environmental information.

1. Aira is not a cure for blindness or low vision. It is designed to address the lack of immediate access to visual and environmental information.

2. Aira's culture and creative drive is centered on thinking like a set of eyes rather than thinking like a brain. It is a simple yet powerful concept. The person receiving the information decides what to do with it. We are the eyes. Not the brain.

3. Aira's services are enabled by technology but delivered through human-to-human interactions, a partnership of equals.

At its heart, Aira is about information. It is about eliminating that gap in information that a person with blindness has and that inhibits the ability to make informed choices. And it is about shrinking the time it takes for a person to get that information.

Targeting Employment

Recognizing the need for additional efforts to enable people who are blind to pursue employment, Aira recently announced that all activities related to preparing for and finding a job would be free to our users. Aira is also working with the public and private vocational rehabilitation system, as well as employers, to support access to visual information in the workplace. One quarter of the service minutes we provide are tied to employment-related activities. More information about this initiative can be found at https://go.aira.io/employment.

Partnership with AT&T and the Blindness Community

Aira is proud to have the support and partnership of AT&T as our primary source for wireless connectivity, including AT&T's Dynamic Traffic Management (DTM) solution. AT&T's Foundry for Connected Health is working with Aira on several projects including development and testing of a solution designed to help people who are blind or have low vision reliably access medication labels and information. This is one of the most requested features

among Aira's customers. The solution will utilize "Hey Chloe™," Aira's new artificial
intelligence (AI) platform, to correctly identify prescriptions and over-the-counter medications.
To support educational opportunities, AT&T, Aira and the National Federation of the Blind
(NFB) joined forces to make the transition to college easier for 100 blind students by giving
them Aira smart glasses. AT&T funded the innovative back-to-school program.

Aira also enjoys a close partnership with leading organizations in the vision loss
community. The American Council of the Blind, The American Foundation for the Blind, the
National Federation of the Blind and Blinded Veterans Association are Aira partners and
advisors.

Communications Networks

As a cloud-based service, Aira relies on both mobile communications networks and the
Internet. Live video, along with GPS and other sensor data, is transmitted directly from the Aira
user's smart glasses through a mobile network to an Aira agent's dashboard. The sophisticated
dashboard is built to support an augmented reality context combining live data streams and
interaction capabilities. Working from their dashboard, Aira's agents can access myriad sources
of information – the video streaming from the explorer's glasses or smartphone, along with GPS
and other sensor data, and of course audio. The agent can also leverage web-based maps,
transportation routes/schedules, and other online information to assist our explorers in virtually
any activity).

As a mobile and Internet-based service, Aira is designed to be widely available,
supporting our Explorers/ need for access to visual information anywhere, at any time. A robust
network with dependable connectivity is an absolute requirement. Aira requires a minimum
variable bit rate (VBR) transmission of 720 Kbps to 1 Mbps to deliver 640x480 video

resolution at 15fps. However, a more effective result requires an optimal (VBR) of 2-4 Mbps to deliver 1280x720 resolution at 30fps. For the most reliable data feed, we need constant bit rate. AT&T's DTM has been key in ensuring that our users have ultra-low latency and robust mobile connectivity for the transmission of streaming video on which our agents rely to provide guidance and support with visual tasks. Securing efficient and reliable access to information instantly, anywhere and anytime is essential. Delays of more than a few milliseconds would severely limit the value of the service. Using priority network services provided by AT&T, we record only 80 milliseconds of latency, which is near real time, ensuring better reliability and consistent bandwidth availability for transmission of high-quality video streaming.

Service Models

Aira launched as a direct-to-consumer subscription service. Our Explorers pay for access to a fixed number of minutes of service per month. We have expended considerable effort to work with agencies such as the Department of Veterans Affairs to ensure that our nation's veterans who lost their sight in service to our country can continue to access visual information and remain independent and productive. We are also reaching out to veteran's service organizations to recruit veterans with disabilities to serve as agents, creating opportunities for veterans to assist their fellow veterans. Aira is also working with vocational rehabilitation providers and encouraging other third-party payers to include coverage so that consumers with limited incomes can make use of the service.

More recently, Aira launched a site-access program to allow public facilities (such as airports or transit stations), retail centers, government facilities, and other service-providing agencies to cover the cost of Aira service within their locations. This "public Aira" provides

access to the visual information needed to support independent navigation by individuals with vision loss.

Through these and other models, Aira is working to sustain and expand our support for individuals with vision loss. We are also investigating services to other disability groups as well. Innovation

From our inception, Aira has invested in engineering and other technical expertise to build our innovative service. Reliability and ease-of-use are critical as are the efficiency and quality of the video and audio connection. Because we understand that "hands-free" access is essential, we deploy video camera-equipped smart glasses to facilitate the connection from Explorer to agent. Initially, we used existing technology. However, Aira recently launched our Horizon hardware, which features smart glasses designed by Aira and built in the United States, largely by companies based near San Diego. These glasses provide a superior field of vision for the video camera and battery life that supports up to seven hours of continuous use.

We have also continually updated the platform to provide new services, such as integration with ride-sharing entities Lyft and Uber. The work we are undertaking with AT&T to enhance access to prescription and medication information is another example.

The "AI" in Aira's name signifies the importance of artificial intelligence to our platform. We have hired AI expertise and we are working with the most capable technology companies to deploy support for automated services in the Aira platform. We launched Horizon with AI-agent, "Hey Chloe™" functionality, and we will expand her capabilities.

To maximize AI functionality, the local device and cloud-based capacity must work in conjunction. While AI solutions can be developed to run on a smartphone device, AI scales better in a cloud-based environment because of the theoretically unlimited computing resources

in the cloud. However, limited network capacity has meant that the performance of running AI locally is better than on the cloud. The weak medium here is the network. Fortunately, the emergence of the 5G network exponentially increases data transfers that will enable local devices to be powered by cloud-based support. Aira looks forward to the development of 5G networks which will fill a gap in today's technology to support our vision of creating smart communities that enable a level playing field for people of all abilities.

Thank you for the opportunity to testify before the Subcommittee. I look forward to discussing Aira, our technology and access to visual information. We encourage policymakers and regulators to support policies and programs which promote and expand reliable access to visual information as a right for individuals who are blind or visually impaired.

Aira Awards/Honors (Since 2015)

--2018: Aira receives bronze medal as a finalist in the prestigious **2018 Edison Awards** which recognizes the nation's top technology industry leaders, innovators and entrepreneurs who are driving innovation and new product development.

--2018: Aira Co-founder and CEO, Suman Kanuganti named semi-finalist for **Ernst & Young's Entrepreneur of the Year 2018 Award.** Winner to be announced in May 2018.

--2018: Aira shortlisted for **Global Mobile Award** of the Mobile World Congress in Barcelona, Spain which recognizes the world's top innovators in mobile technology.

2018: The publication, MedTech Boston names Aira as among the **top 4 digital health startup companies using the Internet of Things (IoT) to improve healthcare.**

--2017: The New York Times cites Aira as among the emerging tech startups that are using its powers for good in society, earning these companies the **NY Times' 'Actually Good Tech Awards' for 2017.**

--2017: As further testament to Aira's groundbreaking technology, Smithsonian Magazine features Aira Co-founder and CEO, **Suman Kanuganti as among the 9 Innovators to Watch in 2018.**

--2017: Aira's partnership with Memphis International Airport -- in which this facility became the first airport to offer Aira's blind and low-vision users free access to Aira services while they travel through the complex -- **is cited by USA Today as among the best new airport amenities of 2017.**

--2017: Selected as **Startup of the Year by the Consumer Technology Association (CTA).** The CTA is the consumer technology industry's leading proponent of innovation, technology and entrepreneurship.

--2017: Named **Finalist for *Innovations in Healthcare*™ ABBY Awards.**

--2017: The Medical Futurist, a leading healthcare tech publication, **rated Aira as among the top nine augmented reality (AR) technology companies** in the

health/medical industry. It cited Aira's augmented reality-powered solutions that offer the blind and visually impaired the opportunity to live more independently.

2017: Selected as **Speaker/Presenter at the prestigious GSMA Mobile World Congress Conference (Barcelona, Spain) taking place in 2018.**

--2017: Aira named *"Best in Show" and nominated as "Best Tech"* at the Mobile World Congress exhibition in Barcelona, Spain where Aira's new smart glasses, and the newly announced partnership with AT&T, were showcased.

--2017: Aira named by PC Magazine as *"Best New Technology"* at the international CES (Consumer Electronics Show) in Las Vegas. At CES, Engadget magazine also nominated Aira as finalist for the publication's *"Best of CES 2017" Awards.*

2017: Aira named winner in the Consumer Technology Association *Eureka Park 2016 Accessibility Competition (Awarded* at CES 2017). The Award recognizes innovations that have the potential for a positive impact on older adults and people with disabilities.

2017: Named Winner of California State Fair's *Champions of Technology Award* (in the Project/Organization Category), recognizing Aira as a key innovator whose technology has direct benefit to Californians.

2017: Aira Named Finalist in the 2017 *Mobile World Congress International d-LAB Pilot Challenge* in Barcelona, Spain. The competition recognizes outstanding mobile technologies who have particular potential in being integrated into Spanish and other foreign markets.

2017: Suman receives San Diego Business Journal's *'Most Admired CEO Award'* . The award recognizes local entrepreneurs for their outstanding leadership in driving their business while also making a significant impact on their companies and the San Diego community.

2017: Aira Awarded Honorable Mention in *FCC Chairman's AAA* competition for Advancing Innovation in Accessibility Technology. In accepting the award, Aira was among key innovators in communications technology for the disabled who were honored by Ajit Pai, Chairman of the Federal Communications Commission (FCC). Pai honored the innovators for being selected among the nation's best in the FCC Chairman's Awards for Advancement in Accessibility (or Chairman's AAA).

--2016: Aira named a winner of San Diego CONNECT's prestigious *'Most Innovative New Products Awards'* competition (in the Information Communications Technologies category). CONNECT is a premier accelerator in San Diego for highly innovative area companies in the technology and life sciences sectors.

--2016: Aira is selected finalist in the *Wall Street Journal's prestigious WSJDLive competition* that showcases innovative startups globally. Aira was selected from among 400 applicants worldwide.

--2016: Aira is selected a winner in the 2016 *Red Herring Top 100* North American technology competition which honors some of the world's best high technology innovators, venture investors and business decision makers who are driving the economy.

--2015: Aira selected "Best New Startup" at AWS (Amazon Web Services) Loft Startup Pitch Event, San Francisco.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Wood, 5 minutes.

STATEMENT OF MATTHEW F. WOOD

Mr. WOOD. Chairman Blackburn and Ranking Member Doyle, and members of the subcommittee, thank you for having me here today to testify.

Free Press is a nonpartisan nonprofit with 1.4 million members, and we were founded 15 years ago to elevate people's voices in policy decisions that shape our media.

Today, we believe that achieving racial justice and social justice require equitable access to technology and information. That's why we work on net neutrality.

We supported the strong rules recently and wrongly repealed by the FCC, and we support Congressman Doyle's resolution to restore them, and we are not alone.

Hundreds of members have cosponsored that resolution in the House and Senate. Thousands of businesses and organizations and State and local officials support it, too.

Millions of people have made their voices heard, first at the FCC and then in these halls, opposing that repeal and calling on you to pass the CRA.

That's not surprising, because, as Mr. Doyle noted, poll after poll shows the net neutrality rules enjoy tremendous popular support across party lines.

One poll last summer showed that 72 percent of Republicans supported the 2015 rules. Another taken before the FCC's December vote found that 83 percent of all respondents oppose that repeal.

Free Press supports restoring the entire 2015 order because we need more than three bright lines to preserve the open internet. We need FCC authority to prevent new forms of discrimination and also to address digital divides, protect privacy, and promote competition.

Yet some people claim that paid prioritization bans are harmful and they say that ISPs should be able to charge new kinds of fees and that internet users and businesses would benefit from such new charges.

They also say this would help with last-mile congestion without explaining its scope or accounting for the ways the networks already deal with that.

As a general matter, prioritizing rather than building capacity to solve any last-mile congestion over a sustained period would let ISPs profit from artificial scarcity.

It would let them charge more to get through the bottleneck rather than building a bigger path. So paid prioritization is not just a solution in search of a problem, it's a toll booth in search of a traffic jam.

ISPs' own data shows that under Title II, both broadband investment and deployment speeds increased markedly in rural and urban areas alike.

Despite that evidence, some still insist that strong rules made ISPs invest too little. Now, funnily enough, we are told that the rules may make ISPs invest too much by requiring them to build

both excess capacity instead of prioritizing their way out of congestion.

Whatever the investment incentives of the paid prioritization ban, discarding this rule would cause a radical change to the internet.

That ban prohibited ISPs favoring traffic only in exchange for payment from a third party or to benefit an ISP's affiliates such as video or voice offers.

In other words, it did not ban the kinds of user-directed and application-driven traffic management techniques praised by others here today.

Those kinds of practices leave ISPs' customers in control when it comes to choosing how to use those connections, and those customers already can and do choose to buy faster speed tiers when they so desire.

They could even buy what's called a quality of service tier to use on applications of their choosing and at times of their own choosing.

Longstanding network protocols also can and do make these kinds of choices neutrally. ISPs don't need to inspect our internet traffic as they transmit it or to second guess how to treat it.

The paid priority rule banned none of these network management techniques. It applied only if the ISP tried to make a content provider pay extra just to reach broadband customers or just to cut in line ahead of other traffic.

People already pay for their connections. The websites and apps they visit should not suddenly be asked to do so too. So if I visit marshablackburn.com or mikedoyleforcongress.com on my home connection, those websites don't have to pay my ISP to reach me.

Let me be clear. I am not here to defend big edge providers from such payments. I represent internet users. But letting gatekeeper ISPs impose new tolls would distort the choices users have and ISPs undoubtedly would get together with those largest edge providers to set the terms and prices for any such advantages.

It would be inefficient for every edge provider to have to strike such deals with every ISP in the country, and signing up for such deals means they'd be double charged for data that ISP subscribers already paid to receive.

Academics can speculate that in a different kind of access market such new fees might reduce subscriber costs. They still do not explain why ISPs facing so little competition would have any incentive to lower their retail prices.

So when ISP executives talk about paid prioritization, they don't describe it as a way to reduce revenues or to replace the source for those revenues. They talk about it as a chance to increase their revenues.

That's why the notion that new ISP fees might benefit internet users and reduce their prices brings to mind a joke I've heard on several occasions. But with all due respect to the originator of that joke, I think that the most terrifying words in the language may be, "I am from the cable company. I am here to save you money."

Thank you very much, and I look forward to your questions.

[The prepared statement of Mr. Wood follows:]

FP Free Press

Written Testimony of

Matthew F. Wood
Policy Director
Free Press and the **Free Press Action Fund**

before the

Congress of the United States
House of Representatives
Committee on Energy and Commerce
Subcommittee on Communications and Technology

regarding

"From Core to Edge: Perspective on Internet Prioritization."

April 17, 2018

SUMMARY

Net Neutrality enjoys tremendous popular support across party lines. That support extends not only to the general framework in the 2015 *Open Internet Order*, but the belief that small businesses cannot afford to pay for prioritization. Yet after the FCC's repeal of rules banning such payments, there are disagreements about whether Congress might restore them.

Net Neutrality opponents oppose restoration of the 2015 rules and successful legal framework. Among the arguments they make for dismantling the rules or weakening them in Congress is their claim that the paid prioritization ban is harmful. They say ISPs should indeed be able to charge new kinds of fees, arguing that users and business would benefit from such new charges and that such fees would help last-mile network congestion.

As a general matter, prioritizing rather than building capacity to solve sustained congestion would misalign ISP incentives, letting them profit from artificial scarcity rather than encouraging deployment. Free Press used ISPs' own data to show that under the rules the FCC voted to abandon, broadband investment and speeds increased in rural and urban areas alike.

Jettisoning the paid prioritization ban would upset that balance and radically change the internet in the bargain. The ban only prevented ISPs' from favoring traffic in exchange for payment from third parties, or to benefit an ISP's affiliated video or voice offers. It did not ban user-directed traffic management, or innovations that might depend on that. ISP customers already can and do buy faster sped tiers. They could even buy higher quality of service ("QoS") – for apps of their choosing, at times of their choosing. Longstanding network protocols also can and do and make choices neutrally without ISPs inspecting traffic or second-guessing protocols.

Academics may speculate that such new fees might reduce subscriber costs, but do not explain why ISPs facing so little competition would have any incentive to lower retail prices.

INTRODUCTION

Chairman Blackburn, Ranking Member Doyle, Chairman Walden, Ranking Member Pallone, and Members of the Subcommittee: thank you for inviting me to testify in this hearing entitled "From Core to Edge: Perspective on Internet Prioritization."

Free Press and the Free Press Action Fund (together, "Free Press") are nonpartisan, non-profit organizations with 1.4 million members around the country and around the world. We were founded fifteen years ago to elevate people's voices in the policy decisions that shape the media landscape. Today we believe that achieving racial and social justice means achieving equitable access to technology and information. That's why we've worked on Net Neutrality for almost all of our fifteen years. During much of our history, and over the course of a now decade-plus legal battle on this issue, Free Press has been a leader in advocating for open internet principles based on a strong legal foundation.

That is why we supported the strong open internet rules adopted in 2015,[1] before they were recently (and wrongly) repealed by the current FCC.[2] That is also why we support Congressman Doyle's resolution under the Congressional Review Act ("CRA") to restore them.[3]

We are not alone. Hundreds of Members of Congress have co-sponsored that resolution in the House and Senate. Thousands of businesses, organizations, and state and local officials support it too. Millions of people made their voices heard, first at the FCC to oppose that repeal; and then in the Halls of Congress too, calling on you to stop Chairman Pai's plan and now calling on you to pass the CRA.

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[1] *Restoring Internet Freedom*, WC Docket No. 17-108, Declaratory Ruling, Report and Order, and Order, FCC 17-166 (rel. Jan. 4, 2018) ("*2017 Net Neutrality Repeal*").

[2] *Protecting and Promoting the Open Internet*, GN Docket No. 14-28, Report and Order on Remand, Declaratory Ruling, and Order, 30 FCC Rcd 5601 (2015) ("*Open Internet Order*").

[3] *See* H.J. Res. 129, 115th Congress (2018).

That's not surprising: poll after poll shows that Net Neutrality enjoys tremendous popular support across party lines. Only inside the beltway and buildings like these does this (sometimes) remain a partisan issue. Results like that this have helped change the debate. We welcome the newfound expression of commitments from lawmakers on both sides of the aisle to preserve fundamental communications rights.

Now, instead of hearing from ISPs that Net Neutrality is a solution in search of a problem, we've heard Chairman Walden say Chairman Blackburn's bill might "help solve a very complicated problem."[4]

Yet there are disagreements about how solve it. Free Press supports restoring the entire 2015 FCC order. We need more than three "bright lines" to preserve the open internet. We need FCC authority to prevent new forms of discrimination, and also to address digital divides, protect privacy, and promote competition.

THE 2015 *OPEN INTERNET ORDER* STRUCK THE RIGHT BALANCE.

On December 14, 2017, the FCC voted 3 to 2 to repeal rules set in place in 2015. The repeal abdicated the agency's congressional mandate to prevent unreasonable ISP practices. Contrary to ISPs' talking points, the 2017 repeal did not restore a "light-touch" regulatory framework for internet access: it repealed all rules preventing ISP blocking, throttling, paid prioritization and other forms of unreasonable discrimination, and it tossed aside the only legal foundation upheld in court for such rules. The prior FCC had restored that proper legal framework in 2015, after Verizon appealed and overturned an earlier version of these rules grounded on the weaker statutory authority in Section 706 of the 1996 Telecommunications Act that ISPs later said they would have preferred.

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[4] "Chairman Walden Statement on the Open Internet Preservation Act," Dec. 19, 2017, https://energycommerce.house.gov/news/press-release/chairman-walden-statement-open-internet-preservation-act/.

The FCC's 2017 reversals leave internet users without sufficient protections, not only against Net Neutrality violations like blocking content or slowing it down, but also against privacy violations if ISPs make unauthorized and unpermitted use of customers' personal data. The FCC's recent repeal also purported to preempt states' attempts to fill this vacuum and restore these rights. And as this hearing should show, repealing the rule that prohibited "paid prioritization" by ISPs only harms internet users and innovators. It does so by creating the possibility that ISPs could for the first time charge third parties who are not their broadband customers for delivering traffic those broadband customers already paid to send and receive.

The FCC's 2017 abdication puts internet users at risk. It jeopardizes the ability of individual internet users, businesses, educational institutions, elected officials, and other political speakers to participate in the civic and economic life of the country. Net Neutrality is important not only for small businesses and commerce, but also for free speech and democracy. These protections are particularly important for communities of color and other marginalized groups, as they let people make their voices heard on the internet and bypass traditional media gatekeepers.

The fight to restore these protections is gathering momentum, with tens of millions of people organizing to reinstate the rules. In addition to the Congressional Review Act efforts, some twenty-three state attorneys general have joined in a federal appeal of the FCC's decision. Free Press is among dozens of public interest organization, private companies, and state and local officials that will be involved in this litigation too.

There is good explanation for all of this energy: Net Neutrality rules are immensely popular. Poll after poll shows strong support for the rules, and opposition to the FCC's repeal decision, with consensus across party lines. This polling even shows strong support for the legal foundation and conceptual framework underpinning those now-repealed rules.

Internet Users Oppose the Kind of Paid Prioritization the Net Neutrality Rules Banned.

For instance, one poll released in July 2017, conducted by Freedman Consulting and Civis Analytics, shows that 88 percent of respondents agreed with the statement "when I buy internet service, I am paying to transmit information between my computer and the websites I visit, free from interference."[5] It found that "[a] strong majority (77 percent) of Americans support keeping the existing net neutrality rules in place," as did 73 percent of Republicans.

A second poll, also released in July 2017 and conducted by Republican consulting firm IMGE, found that Trump voters believe by more than a 2 to 1 margin that "Internet should be treated like any other utility such as gas or electric service."[6] This poll told respondents that "Companies like Comcast, AT&T, Charter[ ], and Verizon provide home internet access [and] . . . are prohibited from slowing or blocking websites or video services like NetFlix." A full 75 percent of all voters agreed that such rules were necessary, including 72 percent of Republican voters and 75 percent of Trump voters.

Similarly strong majorities overwhelmingly said they would be "concerned if companies like Comcast, AT&T and Verizon could discriminate against main street businesses on the internet" (by a margin of 79 percent to 15 percent). They strongly <u>disagreed</u>, by a tally of 72 percent to 19 percent, "that <u>small businesses like local hardware stores and restaurants should have their websites run slower than bigger national chains that can afford to pay more for paid prioritization</u>."[7]

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[5] "New Poll: Americans Overwhelmingly Support Existing Net Neutrality Rules, Affordable Access, and Competition Among ISPs," at 2 (July 10, 2017), http://tfreedmanconsulting.com.routing.wpmanagedhost.com/wp-content/uploads/2017/07/Tech-Policy-Poll-Summary_Final_20170710.pdf.

[6] "Open Internet Survey: Key Findings," at 3 (July 13, 2017), http://www.incompas.org/files/IMGEInsights-Presentations-KeyFindings-1c.pdf.

[7] *Id.* at 4 (emphasis added).

Those surveys were conducted prior to the FCC's initial comment deadline in July 2017. Yet another survey taken just days before the December 2017 vote, and conducted by the nonpartisan University of Maryland's Program for Public Consultation and Voice of the People, found that 83 percent of Americans did not approve of the FCC's repeal.[8] The partisan split in this more recent poll was slightly larger, but the support level for retaining the rules (and thus opposing what this FCC ultimately voted to do) was even higher than it had been in the summer. Making up the 83 percent total of survey respondents supporting the rules were 88 percent of Democrats, 86 percent of Independents, and 75 percent of Republicans.

Net Neutrality Implements Basic and Vital Nondiscrimination Law for Internet Access.

Net Neutrality's foundation in nondiscrimination law answers contentions that falsely suggest the FCC's 2017 repeal merely rescinded rules that were only in effect for two years and unnecessary to protect the open internet. To the contrary, the Net Neutrality rules wrongly taken away by this FCC are based on longstanding nondiscrimination law for communications services; and they are in need of preservation, whether ISPs violate them or promise not to.

Net Neutrality is a rather well-known term at this point in time – perhaps much to the surprise of those who previously criticized the concept as too weedy or obscure for mass appeal. But in the end, Net Neutrality is a term of art for rules implementing federal law against unreasonable discrimination by the carriers that operate essential broadband telecommunications networks. Even if Net Neutrality were not immensely popular – and the polls cited above show that it is – it would be worth preserving. People's fundamental communications rights, as granted to them by Congress, do not and must not change simply because our communications technologies evolve and improve.

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[8] Program for Public Consultation, Net Neutrality Survey Questionnaire (Dec. 6 – Dec. 8, 2017), http://www.publicconsultation.org/wp-content/uploads/2017/12/Net_Neutrality_Quaire_121217.pdf.

Press, pundits, and ISPs sometimes describe Net Neutrality to lawmakers and the general public as a clash between the likes of Comcast and AT&T, Google and Facebook. The impact of communications policy on the fortunes of these hundred-billion-dollar companies is real (though often exaggerated). Yet the rights enshrined in federal communications law do not exist primarily to protect either ISPs or companies that transmit information to their customers over internet access lines. These rights protect internet users themselves, in their freedom to access the content of their choosing once they have paid for the transmission service that ISPs provide.

Even if ISPs did not routinely interfere with these choices – and history shows that they do[9] – these rights would remain essential. ISPs over time have blocked access to voice and video communications applications like FaceTime and Skype, blocked access to mobile payment apps that competed with their own apps of this sort, and slowed or blocked access to video content that competed with ISPs' legacy cable television offerings. In fact, as research conducted by the Open Technology Institute showed,[10] there were significant and sustained end-user harms as a result of interconnection disputes from 2013 to at least 2014, with millions of people not receiving broadband service they paid for and suffering from unusable speeds for months on end.

The law that establishes these rights, as well as the FCC's mandate to protect them, is the Communications Act. It divides communications services into different categories or classifications, including "information services" such as websites, apps or other kinds of content accessed online; and "telecommunications services," which transmit that information to users. Telecom services are governed by Title II of the Communications Act, which applies to telecommunications carriers (also sometimes called "common carriers" as well).

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[9] *See, e.g.*, Tim Karr, "Net Neutrality Violations: A Brief History," Jan. 24, 2018, https://www.freepress.net/our-response/expert-analysis/explainers/net-neutrality-violations-brief-history.

[10] *See Beyond Frustrated*, New America, Nov. 12, 2014, https://www.newamerica.org/oti/policy-papers/beyond-frustrated-the-sweeping-consumer-harms-as-a-result-of-isp-disputes.

The nondiscrimination principles that apply to such carriers has evolved, but those principles have been with us as long as we've had communications networks. ISPs may simultaneously criticize the strong Net Neutrality rules repealed by this FCC as both old-fashioned and untested. The reality is just the opposite: the 2015 rules repealed by this FCC are well-tested. They are based on the same principles that long governed telephone networks, competitive wireless voice services, and business broadband offerings, as well as residential broadband internet access using various technologies at various times over the past two decades.

Yet these principles are also timeless. There is nothing old-fashioned about nondiscrimination law, and it remains as essential for broadband internet access as it does for other telecom offerings. Just as the telephone company can't tell its customers whom to talk to or what to say, ISPs shouldn't be able to dictate or influence what their customers see or say online.

Such nondiscrimination rules are still quite necessary in non-monopoly settings. Many broadband subscribers still face a situation in which they have just one provider of high-speed service available; yet the Title II framework has remained in place for wireless voice offerings since the inception of cellular service. Even as Congress and the FCC deregulated pricing for wireless voice in the early 1990s, and refused to adopt rate regulations in that relatively competitive market, these lawmakers still rightly understood the need for regulations preserving nondiscriminatory access on wireless telecom networks in such competitive markets.

Put even more simply, a modicum of competition does not completely obviate the need for Net Neutrality rules. It would seem odd indeed to condone blocking of certain phone calls and phone numbers by Verizon Wireless simply because customers thus blocked might have the option to switch to AT&T, Sprint, or T-Mobile. This is not how communications networks are meant to work, and people understand that.

Until the FCC's drastic repeal, the agency seemed to understand it too. Few questioned the wisdom of FCC rules safeguarding these nondiscrimination rights, and the FCC maintained principles and rules prohibiting ISPs from blocking lawful content or otherwise interfering with their customers' content and application choices. The only question, if any, concerned the proper legal foundation for such rules – and admittedly, that legal foundation did shift over time because the FCC attempted to shift it.

Between 2002 and 2005, in a misguided attempt to more or less completely deregulate broadband, the FCC started to tinker with its service classifications by deciding that broadband was an information service and not a telecom service. The FCC lumped together (for regulatory purposes) a website and the wire over which people access that site. Yet the Bush FCC and the first FCC Chairman in the Obama administration still tried to retain Net Neutrality rules.

That approach did not stand up in court. The FCC twice tried to argue that it could prevent blocking, throttling, prioritization, and discrimination by broadband providers without treating those companies as telecom carriers under Title II. It lost both times, first to Comcast in 2010 and then Verizon in 2014. The question about the legal foundation for rules safeguarding these rights took some time to resolve, it is true; but there is a right answer under current law.

Prior to the unfounded and ideologically motivated repeal order issued in December, the FCC had finally settled on a very certain and solid approach. On the third time though the rulemaking process in 2015, the Commission finally got it right. Thanks to millions of people calling on it to do so, the FCC put rules into place that prevented blocking, discrimination, and paid prioritization by ISPs, and it put those rules on solid legal footing by restoring the Title II legal classification for broadband.

STRONG RULES DID NOT DAMPEN ISP INVESTMENT OR DEPLOYMENT.

Any claim that Title II delayed or dampened broadband rollouts simply is not true. ISPs' own data (discussed in somewhat greater detail below and far greater depth in Free Press's FCC comments [11]) proves such arguments wrong beyond a shadow of a doubt. Broadband deployment is by no means satisfactory in every area in the nation. And even when and where fast broadband networks are deployed, not every person can afford to subscribe. That is why Free Press works to guard Lifeline's broadband adoption program from attacks by the Pai FCC, and always advocates for policies that promote universal deployment of robust and affordable services.

Despite the continuing, twin challenges of deployment and affordability, ISPs' own deployment data and investment data show that Title II's reinstatement and the 2015 Net Neutrality rules did not slow down deployment, speed upgrades, or overall investment by ISPs. The data that these companies report to the FCC – and also to their own investors, to Wall Street analysts, and to the U.S. Securities and Exchange Commission – all show that deployment continued apace during the time that Title II was in place.

To reach this conclusion, Free Press analyzed FCC Form 477 deployment data to answer what should be the central question on this topic for all policymakers: how did the broadband market's capacity and capability change after the FCC's 2015 Title II reclassification and adoption of Net Neutrality protections? This self-reported data is a rich source of information on broadband deployment, the types of technology ISPs offer, and the transmission speeds available for every Census Block in which they offer broadband. Free Press has analyzed changes in this data since December 31, 2014, just prior to the FCC's adoption of the now-repealed 2015 order.

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[11] *E.g.*, Comments of Free Press, WC Docket No. 17-108, at 86–294 (filed July 17, 2017) ("Free Press Comments").

Our analysis of this FCC broadband deployment data shows that the national broadband market continued to thrive after Title II reclassification.[12] We found that:

- The number of Census blocks with two or more ISPs offering service with downstream speeds at or above 25 Mbps increased by 42 percent following the *Open Internet Order*.

- At the end of 2014, approximately one-third of the population had access to two or more ISPs offering 25 Mbps or higher-level services. By mid-2016, more than half of the population could purchase broadband at this speed threshold from two or more ISPs.

- At the end of 2014, only 10.5 percent of the population had access to one or more wired ISPs offering consumer services above the 300 Mbps downstream threshold. But just 18 months later, this had more than doubled to nearly 23 percent of the population able to access this level of broadband service.

- In Census Blocks with cable DOCSIS 3.0 services, the average available speed of this technology increased from 118 Mbps to 173 Mbps (47 percent). In blocks with fiber to the home, its average available speed increased from 251 Mbps to 380 Mbps (51 percent). And average available VDSL downstream speeds more than doubled, from 24 Mbps to 52 Mbps.

- Examples of specific ISP company growth include:
  - Comcast sharply increasing the speeds of its offerings in the months following the *Open Internet Order*, from a Census block-average of 129 Mbps to 191 Mbps.
  - Cox going from offering 300 Mbps and higher-level service in none of its Census blocks to doing so in 68 percent of its blocks following the *Open Internet Order*.
  - AT&T improving from offering 25 Mbps and higher-level downstream speeds to consumers in just 5 percent of its Census blocks in 2014, but by mid-2016 offering this level of service in nearly 40 percent of its territory – a massive increase reaching more than 50 percent of the population in AT&T's service area.
  - In rural blocks, AT&T's average available downstream speed doubling to 18 Mbps during the period following adoption of the *Open Internet Order*.

- Among cable ISPs (which disclose in their quarterly SEC filings the specific amounts of capital expenditures they devote to network infrastructure):
  - During the two years following the *Open Internet Order* vote, cable-industry physical-network investments increased 48 percent when compared to the amount invested in such facilities during the two prior years.
  - Cable's core network investments accelerated dramatically during 2016 (a $2.1 billion increase over 2015, compared to 2015's $0.8 billion increase over 2014).
  - That one-year increase in cable-industry core network investments during 2016 marked the biggest single-year jump since 1999.

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[12] *See* Reply Comments of Free Press, WC Docket No. 17-108, at 21 (filed Aug. 30, 2017).

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The period after adoption of the *Open Internet Order*, and prior to this FCC's vote to repeal it, saw historic levels of investment, deployment, and innovation across the entire internet ecosystem. In addition to the numbers we presented regarding deployment and investment, we copiously documented each publicly traded ISPs' comments made to their own investors and investor analysts, which clearly reflected these broadband providers' justified belief that the Commission's 2015 order had no negative impact on their broadband deployments.

Net Neutrality Rules Banning Paid Prioritization Work to Align ISP Incentives Correctly.

These real-world facts and figures are curiously – and even irreconcilably – at odds with theories advanced by paid prioritization proponents as much as a decade ago and as recently as two weeks before this hearing.

On the one hand, these theorists have speculated that without paid prioritization capacity upgrades simply won't happen. One wrote in 2007 that with "the advent of streaming video and other bandwidth-intensive applications, the demand for bandwidth [was] projected to overtake the existing supply quickly." He cautioned that "[r]egulators and legislators should not interfere with a broadband service provider's ability to manage this 'coming exaflood' with intelligent networks," because without prioritization "the price of Internet service will skyrocket if [ISPs] can meet the coming traffic using only expanded infrastructure [or] the Internet experience for all users will deteriorate."[13] Of course, we see instead that broadband providers of all types have dramatically expanded capacities and continued to meet demand – for the most part, though with notable exceptions, done without resorting to discriminatory routing, charging "skyrocketing" prices, or uniformly letting user experiences deteriorate.

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[13] Hal J. Singer, "Net Neutrality: A Radical Form of Non-Discrimination," *Regulation* (Summer 2007).

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On the other hand, and far more recently, another academic echoed the notion that "additional capacity is expensive," coupling it with the rather truism that it generally would be "uneconomic to build a network with zero congestion at peak time because this would create significant excess capacity at off-peak periods."[14] (Of course, no broadband internet access network is engineered for "zero congestion" at peak time, and as discussed below, network management already occurs without paid prioritization.)

The shift here over the course of a decade and two authors is subtle but substantial. Paid prioritization is still seen as a way to manage congestion, though no longer offered up as the only way to staunch the "coming exaflood" otherwise supposed to swamp the internet. But after years of attacks claiming Title II, strong Net Neutrality rules, and the paid prioritization ban in particular would dampen broadband investment or even make it uneconomic, we're now told that paid prioritization may actually spare ISPs from spending so much to deploy in "capacity-constrained" rural areas. That's a particularly bitter pill to swallow in the wake of so much ISP lobbying money spent to suggest that Net Neutrality rules kill investment: now we're told that instead of making ISPs invest too little, they make ISPs invest too much!

With the prospect of paid prioritization made a reality again by the FCC's repeal, we can see such schemes for what they are: a tollbooth in search of a traffic jam. The deployment and speed increases documented above are the better outcome, and the one expected from the FCC's 2015 order (seemingly) settling the legal uncertainty. ISPs then understood their path to prosperity depended not on discriminatory schemes, but on selling users the capacities they demand – much of that created by the exponential growth in online content and applications.

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[14] Daniel Lyons, "Paid prioritization: Debunking the myth of fast and slow lanes," *AEIdeas*, Apr. 2, 2018. The Lyons piece offers a few additional arguments easily rebutted by the sections of this testimony that follow. Lyons' biggest red herring is his insinuation that Net Neutrality proponents suggest "central planning" as the only alternative to price mechanisms such as having third parties pay that price.

There is no evidence of any change in 2015 and 2016 to the *status quo* buildout trajectory. This strongly suggests that the central premise of the FCC's repeal was completely wrong. There is simply no evidence that restoration of Title II, and codification of basic Net Neutrality duties, negatively impacted the nation's broadband internet access market.

In our comments in the FCC's 2017 rulemaking docket, we documented extensively how the internet access and online content markets continued to thrive after that 2015 FCC's decision. Broadband access companies large and small increased their capital investments, and uniformly told their investors that Title II reclassification had not impacted their deployment plans. And with the confidence that ISPs would not be allowed to implement discriminatory shakedown schemes, online content and service providers increased their investments too.

Broadband Investment Increased, But Raw Investment Is Still the Wrong Metric.

In our reports and filings, we also cautioned that what matters most is not the raw dollar amount ISPs invest each year in capital equipment. What matters most is deployment of broadband capacity, and progress in improving on what little competition exists in this highly concentrated industry. The facts and figures recited above show that there was progress in those important areas. Policymakers and internet users shouldn't dwell on whether or not an ISP spent more in a given year than it did the prior year; they should care if that ISP and its competitors continued to rollout better quality and more competitive services.

Yet with those caveats in mind, we have also shown in our thoroughly documented and researched comments and reports that aggregate investment by the broadband industry increased during this time period too – again, contrary to the claims made by some of the ISPs' lobbyists and by FCC commissioners that voted for repeal.

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Free Press's compilation of broadband industry investment totals, as publicly traded broadband internet access service providers themselves reported this data for the two years preceding the FCC's February 2015 vote and the two years following it, conclusively demonstrates that the investment total for all of these publicly traded ISPs together increased by 5.3 percent for the two-year period following the adoption of the 2015 Net Neutrality rules.[15]

Those who still insist on incorrectly claiming some harm to broadband investment from Title II focus on supposed decreases in this aggregate figure, but the manipulated totals they cite stem from vague and unspecified tabulations for the broadband industry as a whole. These commenters also distort the amount invested by certain providers while ignoring freely available public statements explaining individual firms' decisions.[16]

Even were these manipulated aggregate figures correct (and they are not), a myopic focus on raw dollars spent ignores the Commission's statutory mandate to promote deployment – as well as the overwhelming evidence that deployment continued (and even improved) in the years following the order.

The blunt measure of an aggregate total is easily swayed by changes in either direction at any large firm, and it obscures changes (if any) in investment decisions, cycles, and strategies by all of the individual firms that make up the aggregate total. Looking at those individual results, the majority of publicly traded broadband providers in their own financial disclosures reported investment increases after the vote. This fact alone does much to disprove the fanciful notion that Title II was a systemic threat or source of harm to investment across the entire industry.

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[15] *See* Free Press Comments at 129–130 & Fig. 24.

[16] *See id.* at 145–151; *see also id.* at 151 (quoting AT&T's explanation that the company's costs were falling due to technological improvements and the efficiencies therefrom, not due to any regulatory concerns, as evidenced by the fact that AT&T was then "going to deploy more fiber next year than we did this year, but the capital requirements are going down").

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Twice as many individual ISPs increased their capital spending as the relative few that decreased it. Several individual ISPs increased their capital spending by double digits. To name just a few specific examples, <u>Comcast's total capital spending for the two years following the 2015 vote increased by 26 percent, Verizon's by 3 percent, and Charter's by 15 percent</u>.

As Free Press has copiously documented,[17] again relying on broadband providers' own words, there is no reason to think the relatively few individual ISPs reporting less capital spending decreased it due to Title II. In fact, as AT&T itself has made clear in earlier filings, largely explaining long in advance its own temporary decline following the 2015 vote:

> <u>[T]here is no reason to expect capital expenditures to increase by the same amount year after year. Capital expenditures tend to be "lumpy."</u> Providers make significant expenditures to upgrade and expand their networks in one year (*e.g.*, perhaps because a new generation of technology has just been introduced), and then focus the next year on signing up customers and integrating those new facilities into their existing networks, and then make additional capital expenditures later, and so on. <u>Minor variations from year to year thus should not be surprising[.]</u>[18]

Broadband providers have spoken at length since the 2015 vote and reclassification decision about how they are leveraging technological advances to deploy higher capacities at a <u>lower</u> capital cost than was required in prior upgrade cycles. In the few instances when analysts asked these executives how Title II (or its potential repeal) impacted their company's investments, these executives did not say that Title II had a concrete impact on their own numbers, nor quantify how its repeal would impact their spending.

As a Free Press report prepared almost a year ago explained, and as our further research and analysis in the FCC docket confirmed, the 2015 *Open Internet Order* was working for all parties on the internet: retail users, edge providers, and ISPs too. What is the supposed justification to get rid of the paid prioritization ban, and what would that even entail?

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[17] *See, e.g.*, Free Press Comments at 209–281.

[18] Comments of AT&T, WT Docket No. 10-133, at 34 (filed July 30, 2010); *see also id.* at 39.

THE RULES PROHIBITED PAID PIORITIZATION, NOT ALL PRIORITIZATION.

A cursory glance at the Net Neutrality rules that the Pai FCC voted to repeal shows that they define "paid prioritization" in a manner broad enough to encompass several types of unreasonably discriminatory ISP behavior. Yet the definition is narrow enough to permit multiple methods of traffic management – including even user-directed prioritization, chosen and paid for by an ISP's broadband customers.

Section 8.9 of the FCC's rules, subject to repeal if and when OMB approves the FCC's new information collection requirements in the 2017 order, says in its entirety:

(a) A person engaged in the provision of broadband Internet access service, insofar as such person is so engaged, shall not engage in paid prioritization.

(b) "Paid prioritization" refers to the management of a broadband provider's network to directly or indirectly favor some traffic over other traffic, including through use of techniques such as traffic shaping, prioritization, resource reservation, or other forms of preferential traffic management, either;

(1) In exchange for consideration (monetary or otherwise) from a third party, or

(2) To benefit an affiliated entity.

(c) The Commission may waive the ban on paid prioritization only if the petitioner demonstrates that the practice would provide some significant public interest benefit and would not harm the open nature of the Internet.[19]

As the definition makes clear, management of the broadband provider's network only constitutes prohibited "paid prioritization" if and when it comes in exchange for payment from a third party, or when such traffic management is done to benefit an ISP's affiliated entities (likely but not necessarily offering services such as pay-TV video, online video, or voice). And by third party, the rule means an individual or entity that is not the ISP's own broadband customer, such as the so-called "sender" of data on the other side of the internet connection from the ISP's subscriber or another party that might wish to pay the ISP for some kind of advantage.

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[19] 47 C.F.R. § 8.9 (2017) (emphases added).

Allowing ISPs to Impose Any Charges on Non-Broadband Internet Access Customers Would Be a Radical Shift in How the Internet Works Today.

Thus defined, we can see how even this carefully crafted paid priority ban does more than just prevent unreasonable discrimination by ISPs. It preserves the traditional structure of the internet and ISPs' relationships with their access customers.

Broadband subscribers pay their ISPs to transmit information of the users' choosing. ISPs recover their costs and make their money by selling this service to those users. This is a very different model from the telephone system, for which it took decades of work just to start the transition away from the intercarrier compensation regime that telephone companies and wireless voice providers had to navigate when paying each other to terminate traffic. Whether in recognition of the fact that internet "conversations" may have no obvious sender – because after all, a streaming video app likely sends me traffic only after I first request that video – or simply to embrace the benefits of what telephone carriers might call a "bill and keep" business model, the internet has grown up and flourished this way.

What does this mean in practical terms? When I visit a website, it means that the third party on the other "edge" of the network from my ISP is not suddenly made into a potential paying customer of my ISP. So if MarshaBlackburn.com or MikeDoyleforCongress.com sit on servers connected to the internet by Comcast broadband service, those sites and their owners cannot be made to pay Verizon for delivery of their content simply because I'm a Verizon subscriber at my home. This is a very good thing.

Proponents of paid prioritization often describe it as a benefit – "allowing" distant websites and apps the privilege of paying not just for their own connectivity and upload capacity, but also an additional amount to the ISPs that an edge provider's customers just so happen to use.

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Somehow, the vast majority of internet innovators, investors, entrepreneurs, start-ups, and small businesses seem to think otherwise.[20] They have told the FCC and now Congress, in no uncertain terms, that "letting" apps pay for priority will instead become an obligation to pay for priority – taxing the few edge providers that could afford to pay in an attempt to keep up with the largest and most dominant platforms, and lining ISPs' pockets in the process.

Suggestions that Congress either could or would forbid the sale of paid prioritization to the largest platforms, and thus to the (likely) highest bidders, are outlandish at best. Absent some such law or other highly regulatory intervention to forbid ISPs from selling priority to some buyers, why would any ISP forgo the chance to obtain the highest price? Will Congress in its wisdom, or the ISPs in their good graces, really devise a workable policy to reserve priority treatment only for small businesses or certain kinds of edge providers? The answer is no, unless ISPs really are looking to pick winners and losers by distorting the market for their own services and for the disfavored edge providers denied the chance to buy priority.

Once again, it is important to note that the slim chances for such a plan are a good thing, but not only and not even primarily due to the benefits for app makers and content providers online. Let me be clear: I'm not here to defend edge providers from such payments. I represent internet users. Letting gatekeeper ISPs impose new tolls on the edge would distort the choices users have, and ISPs undoubtedly would get together with the largest edge providers to set the terms and prices for such advantages.

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[20] *See, e.g.,* Fred Wilson, "VC Pitches In A Year Or Two," *AVC Blog,* Jan. 15, 2014, https://avc.com/2014/01/vc-pitches-in-a-year-or-two/ ("Telcos will pick their preferred partners, subsidize the data costs for those apps, and make it much harder for new entrants to compete with the incumbents."); *see also* Letter from Engine Advocacy, Techstars, Y Combinator *et al.* to Hon. Ajit Pai, Chairman, FCC (Apr. 26, 2017), http://www.engine.is/startups-for-net-neutrality/; Letter from American Sustainable Business Council *et al.* to Hon. Ajit Pai, Chairman, FCC (Aug. 31, 2017), https://www.keepthewebopenforbusiness.com/FCC_17-108_smallbusiness-ASBC-filing-170830.pdf.

This would crowd out diverse speakers, startups, and smaller competitors on the internet, all to the detriment of broadband users and the denial of their rights to send and receive the information of their choosing over their connections. As the 2015 *Open Internet Order* rightly decided, allowing third parties to "purchase of priority treatment can lead to degraded performance . . . for traffic that is not covered by such an arrangement," and can "introduce artificial barriers to entry, distort the market, harm competition, harm consumers, discourage innovation, undermine public safety and universal service, and harm free expression."[21]

THIRD PARTY PAID PRIORITIZATION IS NOT THE ONLY WAY TO MANAGE CONGESTION ACCORDING TO NEUTRAL STADARDS OR PRICE MECHANISMS.

Since the FCC's repeal of its Net Neutrality rules and abdication of its responsibility to protect a free and open internet, ISPs have all but announced their intention to deploy not just end-to-end management of traffic but third-party paid prioritization. In their years-long effort to upend these rules, ISPs have consistently touted the supposed benefits of allowing ISPs to pick what internet traffic to move to the head of the queue. Yet allowing ISPs to take advantage of their gatekeeper position by giving priority to the edge providers that can pay them the most will result in all of the harms outlined just above.

What is Last-Mile Prioritization?

As traffic moves throughout the internet or crosses a particular interconnection point or router, the amount of information that can travel through that link is limited by its bandwidth. Most of the time this has no effect on internet traffic, but during peak usage hours nodes of the internet can become congested, slowing down traffic in the network. Under the Net Neutrality rules, ISPs could engage in reasonable network management practices but not charge third parties for prioritization (as defined in Section 8.9 of the 2015 open internet rules).

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[21] *Open Internet Order* ¶ 126 (citations omitted).

Paid prioritization would mean, in times of last-mile congestion, that an ISP would permit information from content providers who have paid them to cut to the front of the line at congested nodes, thus de-prioritizing other customer-selected content.

By Definition, Prioritizing One Bit Slows Down All Other Bits.

Setting aside the differences in first-party payment vs. third-party payment, there is another key difference between prioritization in tasks such as physical parcel delivery and internet routing. The routing of IP data over a given network at a given time is a zero-sum game – even if that prioritization itself may not impair other applications so far as users can perceive it. If a router speeds up one set of bits, by definition all other bits are slowed down or moved down in the queue. Prioritization only has value during times when that network is experiencing congestion; otherwise the bits are routed in a first-in-first-out manner.

What's more, the value of the prioritization to a third-party is directly proportional to how much faster their content loads in comparison to non-prioritized content; but the more priority relationships there are, the less this difference in load time. This means that ISPs wanting to charge third parties for priority (or to violate the other part of the ban in Section 8.9 by prioritizing their affiliates' content) will only be able to prioritize a relatively small amount of content on the whole.

Paid Prioritization Will Entrench Incumbents and Harm the Open Internet.

Despite claims made in the current FCC's Net Neutrality repeal order that paid prioritization might actually encourage the entry of new edge providers, any mechanism that lets third parties who pay the most go first in line at chokepoints will naturally favor the most well-established companies with the deepest pockets to bid on a limited number of priority slots.

The incumbency protection effects of ISPs favoring their own content or content produced by affiliated companies is even more pernicious. Customers have limited choices in their broadband provider and typically purchase only one fixed broadband connection. By prioritizing their own traffic, ISPs could distort the market to favor content they own.

New entrants into the market would be systematically disadvantaged in favor of established firms. This is especially true for content creators from historically disadvantaged communities, for whom a free and open internet creates a more level playing field. A network that does not require content creators to bid for limited priority slots is one where new content and ideas can compete more equitably with content from established firms and without the permission of ISPs.

Banning Paid Prioritization Hardly Means That Priority Cannot Be Assigned Neutrally, Or That It Must Be Assigned in the Absence of Any Price Mechanism.

As suggested above, and as real-world experience makes patently clear, ISPs typically receive payment from their broadband customers to transmit data. Any prioritization or traffic management that must take place when and where congestion arises in a last-mile network can take place in a neutral fashion.

It can be handled in due course by network protocols already used universally (like TCP/IP), or capabilities largely unused today but still written into those protocols (like DiffServ – which contrary to AT&T's assertions over the years does not violate Net Neutrality principles and does not obligate third parties to pay for users' prioritization choices with respect to their own traffic). Lastly, congestion can be handled neutrally, as Comcast decided to do after its BitTorrent blocking scandal, by throttling high-bandwidth users when and where congestion occurs without respect to the source, type, or content of that high-volume user's traffic.

Obviously, in light of the payments that ISPs receive from their broadband customers for internet access, none of these methods to deliver data lacks a "price mechanism" for the allocation of resources. To return to Professor Lyons blog post, and the false dichotomy he suggests by eliding users' "first party" payments to their own ISPs, the only alternative to third-party paid prioritization is not some kind of imperfect and intrusive "central planning model" that must decide based on subjective criteria which service is "more important."[22] Instead, users can pay their ISP for a higher speed tier, increasing the proportion of network resources the ISP allocates to them without concern for the source or type of content they transmit.

USER-PAID PRIORITY IS DIFFERENT FROM THIRD-PARTY PAID PRIORITY.

If such "unpaid" methods – though unpaid only in the sense of there being no separate charge for QoS – are not enough to ensure that a latency-sensitive application works in times of congestion, users could also pay for a service tier that offers not just faster speeds but a QoS promise as well. As one leading Net Neutrality scholar explained at length, a Net Neutrality rule can quite readily support a ban on third-party paid prioritization while still allowing a "type of user-controlled Quality of Service [that] offers the same potential social benefits as other, discriminatory or provider-controlled forms of Quality of Service without the social costs."[23] User-directed QoS could:

> (1) "preserve the application-agnosticism of the network" because QoS provision "is not dependent on which applications users are using, but on the . . . choices that users make; thus, the network providers does not need to know anything about which applications are using its network in order for this scheme to work. The network provider only makes different classes of service available, but does not have any role in deciding which application gets which Quality of Service; this choice is for users to make"; and

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[22] Lyons, *supra* note 14.

[23] Barbara van Schewick, "The Case for Meaningful Network Neutrality Rules," WC Docket No. 17-108, at 21 (filed Aug. 31, 2017),

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(2) provide QoS that meets users' preferences because "users choose when and for which applications to use which type of service . . . even if even if these preferences differ across users or (for a single user) over time."[24]

In the end, there is a better answer for all of the innovations and applications that – according to some Net Neutrality opponents – supposedly "need" third-party paid prioritization to function. That is true whether or not they are telemedicine applications of the sort so often referred to in these debates as the most deserving of priority.

And these other answers have at least one more benefit: they don't paint the absurd or even immoral picture of ISPs like AT&T suggesting that new prioritized pathways are the only way to get the medical services through the traffic – then putting up a toll booth, sticking their hands out, and demanding that lifesaving or emergency applications pay a toll.

PAID PRIORITIZATION FEES WOULD CREATE BARRIERS FOR APPS BUT NOT SAVE INTERNET USERS MONEY.

Suffice it to say that it would be inefficient in the extreme for app makers, websites, online platforms, internet content suppliers, and other edge providers to strike paid prioritization deals with every ISP whose broadband customers they'd like to reach. Even if they could manage it, these edge providers would essentially be double-charged for data that ISP subscribers have already paid to send and receive.

Academics may yet speculate that if we had a different kind of access market, in which broadband customers paid on a strictly metered basis, the new fees paid by edge providers could offset subscriber costs. What these academics cannot explain, however, here in the real world, is why ISPs facing so little competition and no oversight of the fees that might charge in either direction of this two-sided market would have any incentive to lower their retail prices rather than pocketing the additional revenues.

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[24] *Id.* at 21–22.

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When ISP executives talk about paid prioritization, if they do, it seems quite unlikely that they'd describe it as a way to <u>reduce</u> their revenues, or merely to <u>change</u> the source of them from their end-users to the edge. It seems far more likely that they would talk about it (if at all) as a chance to <u>increase</u> those revenues. So in the end, speculation that paid prioritization could save people money is just that: speculation. And it is even less well informed than suggestions that some applications simply "need" priority and need to pay for it themselves too.

CONTENT DELIVERY NETWORKS ARE NOT PRIORITIZATION.

Are there other justifications for lifting the paid prioritization ban, besides supposedly addressing congestion, reducing "excess" broadband investment, and miraculously creating trickle-down savings for internet users? One suggestion is that Content Delivery Networks (or "CDNs") constitute a form of "prioritization" that only large edge providers can afford – and that this advantage might be offset by letting ISPs charge third parties for priority. While there is no time in this testimony to provide a full description of the law, technology, or marketplace realities for CDNs, it is enough to say that this formulation is mistaken in every respect.

First, CDNs do nothing to address last-mile congestion. Edge providers may use CDNs in an attempt to reduce transit costs and latency by storing content closer to the end-user. But CDNs certainly do not prioritize a service by letting it cut to the front of the line for a fee when last-mile congestion occurs. If the term "prioritization" is to have any meaning at all, it must mean placing one message or packet ahead of another one, not simply improving the speed or other performance characteristics of a particular message without moving other packets back in line. That is why even the FCC's 2017 Net Neutrality repeal order conceded that it did "not mean to suggest that CDN services themselves constitute paid prioritization."[25]

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[25] *2017 Net Neutrality Repeal* ¶ 255 n.926.

Second, it's strange to hear that CDNs are expensive or out of reach for <u>any</u> edge provider, small, medium or large, when there are numerous competitive CDNs in the market – including CDN services provided by the largest ISPs themselves. Verizon,[26] Comcast,[27] and AT&T[28] all offer their own CDNs, and they apparently did so for the entire time that the 2015 rules were in effect. They are not typically in the habit of suggesting that their own offerings are unaffordable and ineffective, so perhaps that's why they aren't attending this hearing to make this claim. All kinds of edge providers, large and small, use CDNs. They are not confined to the largest platforms by any stretch.

Third, even if paid prioritization could be used to level the playing field, and offset this supposed advantage that CDNs confer on large edge providers, it's implausible to believe it would be sold this way. As explained above, absent new laws or highly regulatory interventions to forbid ISPs from selling priority to the highest bidder, and to reserve it only for small businesses or certain kinds of edge providers, why would any ISP do this? The answer is it wouldn't, unless that ISP were once again looking to pick winners and losers.

We sometimes talk about artificial scarcity in the broadband market, but there's an artificial abundance of Net Neutrality analogies. Nevertheless, I'll try one here. I'd guess that even in this internet era, most or all Members of Congress still send direct mail during campaign season. Using a CDN is something like using a local printer or direct mail firm to produce, store, and deliver your materials, rather than printing them here in Washington and shipping them back to the district.

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[26] Verizon Digital Media Services, "Better matters: Why our content delivery network is simply better," (last visited Apr, 16, 2018), https://www.verizondigitalmedia.com/platform/edgecast-cdn/.

[27] Comcast Technology Solutions, "Content Delivery Network," (last visited Apr, 16, 2018), https://www.comcasttechnologysolutions.com/our-portfolio/video-platform/content-delivery-network.

[28] AT&T Business, "Content Delivery Network," (last visited Apr, 16, 2018), https://www.business.att.com/solutions/Family/cloud/content-delivery-network/.

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Let's imagine that the market for such services is competitive, just as the CDN market is; and that there are many providers to choose from, just as there are with CDNs today. Now, imagine that in addition to such a service – or instead of one – you got this pitch from the Post Office: why pay for local storage and delivery of mail when you could buy prioritization instead? Not just local storage that cuts down on costs and transit time, available on the same terms and at the same prices to everybody who chooses a particular class of service, regardless of the sender or content of the message. No, prioritization here would mean the ability to cut in line – paying to have your message delivered before your opponent's. Or, heaven forbid, your opponent's ability to do that to you.

I think you'd have little trouble in that case understanding how paid prioritization, achieved by purchasing an advantage and jumping the queue in the last mile, is different from simply ensuring that earlier phases in the transit, storage, and delivery process are fast and efficient. Attempts to conflate CDNs with paid prioritization should be understood the same way.

PLATFORMS' CURATION AND TARGETED ADS AREN'T PRIORITIZATION.

Less than week after the Facebook CEO's hearings in this Committee and in the Senate, the sprawling questions swirling around what to do about online platforms can barely be contained inside all of Washington, DC, let alone inside a single Net Neutrality hearing. Yet from the tenor of some Committee Members' questions last week, it is evident that there has been some thought given to connecting the topic of ISPs' traffic management practices on telecommunications networks and online platforms' practices more generally.

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Before offering even a few thoughts on the topic, one misperception I need to address at the top is the notion that Free Press or other Net Neutrality supporters are unwilling to regulate dominant online platforms and edge providers generally.

Nothing could be further from the truth. When it comes to such platforms' troubling data collection practices and privacy abuses; their pattern of profiting from hate and racism, and from their own or other parties' violations of election law and civil rights law; and their impact on journalism revenues and digital ad competition, Free Press is deeply concerned and researching answers.

We have endorsed the Honest Ads Act to promote greater transparency in political advertising. We supported the FCC's privacy rules in order to protect against abuses by broadband providers; but we certainly support opt-in requirements for edge providers too – frankly, in terms that could require far more than the FCC rules did, and that also go further than Chairman Blackburn's BROWSER Act introduced last year or Senator Markey's CONSENT Act introduced last week. We need more than just general, one-time opt-in requirements, that apply to more than just a pre-defined category of "sensitive information," because we've now seen the many flaws in such approaches.

One person may deem a particular type of personal information "sensitive" even though another does not. So-called non-sensitive information may still be very useful – and valuable – to the entity collecting it and then allowing others to use or misuse it. Opt-in language in privacy policies is not clear or prominent enough; but beyond being written more clearly and placed more conspicuously, it must be more specific and time-bound, explaining exactly what is collected, how it's used, and for how long.

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Without that kind of breadth, depth and specificity for new laws or rules, companies like Facebook could deploy fleets of lobbyists and lawyers to argue quite plausibly that they already comply with a more vaguely drawn opt-in requirement. And that's before we even talk about regulating numerous abuses of data once it is collected, for example by advertisers blatantly allowed to violate housing laws by excluding people based on race, religion, or family status.

But even with all of that hopefully understood, we still reject suggestions made by some advocates today – and even by some sitting members of the majority, or by former Senator Franken in a speech last year – to apply the same kinds of neutrality rules we had for broadband networks and other common carriers to online speakers, curators, or platforms.

I can't help but pause to remark on this ironic twist in the fight against Title II. It seems that some people's rallying cry has become "Don't regulate the internet . . . just the websites!"

Needless to say, a platform like Facebook has tremendous power to shape what its users see – on Facebook and off of it too, thanks to its billions of users and its referral of traffic to other sites. But even with two billion Facebook users worldwide, there are just as many billions of websites, applications, media outlets, and other sources of information online and off. So while Facebook has great sway over news, opinion, and public dialogue, it does not have the same type of power that ISPs could wield to exclude online information from users altogether.

Economic power and political persuasion alone have historically been insufficient in this country to support content restrictions on speakers and editors such as newspapers.[29] Even the spectrum scarcity rationale put forward by the *Red Lion*[30] case to support the FCC's broadcast "Fairness Doctrine" – long disfavored by the Republican party, and long ago cast aside by the FCC – may be subject to challenge in a world of unlicensed spectrum technology.

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[29] *See, e.g., Miami Herald Publishing Co. v. Tornillo*, 418 US 241 (1974).

[30] *Red Lion Broadcasting Co. v. FCC*, 395 U.S. 367 (1969).

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Common carriers, on the other hand, have always been subject to reasonable nondiscrimination rules and not held liable for speech they carry. That remains true today, five years after Verizon dangerously argued in a Net Neutrality appeal that "broadband providers possess 'editorial discretion'" and said that "[j]ust as a newspaper is entitled to decide which content to publish and where, broadband providers may feature some content over others."[31] This is simply not true. Edge providers and other speakers are not the same thing as telecommunications networks.

And just like ISP-owned sites are – whether in Verizon's sprawling Oath empire, that includes legacy AOL and Yahoo! content; on Comcast's NBC and Universal properties; or for the Time Warner content that AT&T hopes to acquire – an online platform or website can and does function as a speaker, editor, or curator of content.

There are interesting academic questions we could take up, about whether or not a large and essential internet platform might be made subject to common carrier rules someday. Though it is also worth noting in that context that those calling to remove internet companies' liability exemptions under Section 230 of the Communications Act would actually encourage more blocking, not less, by treating sites as the publisher of their users' speech and comments.

But the answers to these questions right now are relatively easy. Facebook is not a common carrier. Neither is Twitter, or Google search. Neither is MikeDoyleforCongress.com, MarshaBlackburn.com, or Freepress.net while we're at it. Lawmakers who view this as a game about which sector to regulate, as if it's just a battle between competing interests in Silicon Valley and ISP headquarters, will ensure that their constituents are the real losers in that fight.

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[31] *Verizon v. FCC*, 740 F.3d 623 (2014), Joint Brief for Verizon and MetroPCS at 43 (filed July 2, 2012).

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There are some kinds of privacy and disclosure rules that could or should be made the same for all participants in the internet "ecosystem," and that even could be enforced by the same federal agency so long as it had the power to make rules and then enforce them adequately.

But a one-size-fits-all approach that suggests the same kinds of rules for vastly different kinds of services is never the right approach, and it would not serve anyone well here.

CONCLUSION

Thank you again for the opportunity to testify in this hearing, for your questions during the hearing itself, and for any written questions thereafter. Free Press's position has been and remains that the FCC was wrong to repeal the Net Neutrality rules, its 2015 order, and the legal framework and classification decisions undergirding those earlier policies. We urge you to adopt the resolution of disapproval intended to restore the policies and legal interpretations in place prior to the repeal vote taken by the current FCC majority. And we respectfully remind you that Net Neutrality is not just an astonishingly popular political issue in 2018, but also an essential part of maintaining your constituents' congressionally granted communications rights.

Mrs. BLACKBURN. The gentleman yields back.

This concludes the testimony from our witnesses. We thank you for that, and we will now move to our questions and answers. I will begin and recognize myself for 5 minutes.

Mr. Bennett, I want to come to you first. I want to discuss a tweet from Matthew Prince, the CEO of CloudFlare, from last November.

This exchange occurred on the day the FCC made its Restoring Internet Freedom order available to the public. Someone tweeted a wish that a tech billionaire would buy out the local ISP where Chairman Pai lives and throttle his internet access in retaliation for reversing the previous Commission's order.

Matthew Prince tweeted in reply, "I could do this in a different but equally effective way." He went on to say he had sent a note to his general counsel to see if CloudFlare could throttle Pai's access without breaking any laws.

This tweet certainly raises a number of questions, and in fact it gave us the idea for this hearing. Was Matthew Prince right, and if so, how could he have done this?

Mr. BENNETT. Thank you for the question, Chairman Blackburn.

I remember that exchange. I got involved in it myself, actually. And I think what it illustrates is how the construction of the internet, the structure of the architecture, has changed since the sort of founding days of even really since Tim Wu came up with the idea for net neutrality.

So instead of it being a system that consists of users attached, you know, with their computers and mobile devices to an infrastructure that's provided only by internet service providers, the infrastructure is actually—there's a lot going on in the infrastructure today that didn't used to be there in the very beginning, and content delivery networks have been mentioned several times, and that's one example. Technically, content delivery networks are edge services, but it turns out that all parts of the edge are not equal. So if you put a content delivery network on a portion of the edge close to the end user, then you, by that very act of simply locating the data there, you have moved the data to the head of a line that other suppliers of information that could be, say, on an average of half a nation away would have to join at the back—you know, CDNs put you at the front.

So CloudFlare has a number of—they're actually quite innovative products the company has. So it's sort of a—it's hard to—I am not completely a fan, but some of the things they're doing I think are very beneficial.

I think their primary product is the DDoS protection mechanism so that, you know, sites can be subject to denial-of-service attacks if they are on the wrong side of popular opinion on certain topics, and CloudFlare came up with a way to protect sites that are being hammered with denial-of-service attacks by simply putting a really high bandwidth kind of firewall in front of the site that could absorb the denial-of-service attack and allow the website to continue to function.

Of course, that doesn't always work the way it's planned. I used to be a visiting fellow at the American Enterprise Institute, and we published a blog called Tech Policy Daily, and we used CloudFlare's

free service to protect the blog from denial-of-service attacks. AEI's the kind of organization that's sort of a target for a lot of that sort of antisocial behavior.

But I ran into a situation once where I was unable to access a post that I would written for the blog from my home in Colorado due to a misconfiguration of the CloudFlare.

The CloudFlare had changed some IP addresses. They hadn't told the people at AEI, and so the AEI server, which was not actually owned or controlled by CloudFlare—it was just behind the CloudFlare firewall—was unreachable to me. But people in DC could see it just fine. So it's, like, they were saying, "Why is this a problem?"

Mrs. BLACKBURN. Let me interject and ask you one more question on this. You talked about the CDNs, and as we look at an individual user's access to certain content, who else within this ecosystem would have the opportunity to control that access or to control the speed of the individual's access?

Mr. BENNETT. Well, the CDNs dump so much traffic on the internet I think, as it's covered in the background memo for the hearing, that they're actually in a position to affect the rate at which non-CDN users can get their jobs done.

Mrs. BLACKBURN. OK. My time has expired.

Mr. Doyle.

Mr. DOYLE. Thank you.

A number of witnesses mentioned that 5G will precipitate the need for greater prioritization. If we dramatically increase the capacity of the network service, do we also need to dramatically increase our ability to manage the scarcity of it?

Mr. WOOD. I think not. Congestion doesn't solve every problem, I heard other witnesses say, but it can solve a lot of them, and as I noted in my testimony, certain kinds of prioritization actually do happen already. The question really is who's being made to pay for that.

Mr. DOYLE. You know, a number of witnesses also said in their testimony, they talked about the benefits of ISPs prioritizing certain kinds of traffic over others—for instance, live video, telemedicine, and online games.

But what happens when you take the choice away from consumers of which packets get to them first and ISPs are allowed to decide which applications and application providers will have optimized access to consumers and which ones won't?

I mean, to me it seems like the ISPs get to pick who wins and who loses. What do you think?

Mr. WOOD. Thank you, Congressman.

Yes, we agree. We think retaining that user choice and the rights that users have is very important. And so you're right that certain kinds of traffic might have different network needs at different times.

It should really be up to the user to choose not only which kinds of traffic they might wish to pay for or prioritize but also the source of that traffic. So will all video applications be treated the same way? That's a very tough question to answer when we are leaving that all within the ISPs' control.

Mr. DOYLE. You know, let's talk a little bit about competition. If ISPs were allowed to implement paid prioritization for services such as telemedicine or other services, do you think that would increase or decrease the number of competitive offerings in that space?

Essentially, do you think small, rural health practices or small startups would want to compete against large health systems and the ISPs themselves or other large institutional players?

Mr. WOOD. Yes, Congressman. Thank you.

I think it would decrease the amount of competitors further upstream, if you will. There's some notion that paid priority could be used to level the playing field, I suppose, and let the small businesses compete with the large businesses.

I can't see how that would work. I think that, if there were paid prioritization allowed, then naturally the companies with the deepest pockets and the providers with the biggest bank accounts would pay for that prioritization.

It wouldn't be used to level the playing field. It would just be used to tilt it even further.

Mr. DOYLE. You know, a number of witnesses here today have alleged that the Open Internet Order severely restricted the types of network management an ISP could engage in.

They also alleged that certain types of specialized service offerings such as telemedicine work prohibit it. Further, they claim that prioritization is necessary to ensure the quality of certain services, services, it seems to me, that might be best served using business data services, which I see are claimed to be too expensive.

What do you make of that?

Mr. WOOD. Well, there's a lot there. I do think that the Open Internet Order of 2015 did allow for reasonable network management. It was the term of art used for several of the rules. So even for blocking or for throttling, there were network management exceptions.

For a prioritization, there was no such exception, but, of course, as I noted this morning, the ban only applied to third-party payments or prioritization done to benefit an affiliate of the internet service provider.

So all kinds of applications could receive network management. You mentioned specialized services and other kinds of dedicated capacity. Those were fully allowed by the 2015 order, and, again, even when there is a use case for prioritization on the open internet without going to a specialized service or dedicated capacity, there are protocols and methods for doing that today.

They just simply don't require the edge provider to pay on top of what the broadband user is already paying for their service.

Mr. DOYLE. Right.

Mr. Wood, the ban on paid prioritization, or pay to play, that was a fundamental part of net neutrality, and throughout the proceeding to eliminate neutrality protections, Chairman Pai repeatedly said that the 2015 net neutrality order was a departure from the past.

Yet, as far back as the 1970s the Commission had identified the potential harmful effects that could result when just a handful of gatekeepers could control consumers' access to the internet.

Has the internet always been open and free?

Mr. WOOD. We certainly think so. In the old days, you might call it, broadband providers were Title II providers. Your dial-up service worked over a phone line, and that phone company was subject to nondiscrimination rules.

So, although the legal ground for net neutrality has shifted somewhat over the last decade as different administrations have tried to do it in different ways, the protections have always been there, and we think the 2015 version did the best job of restoring the protections we've always had.

Mr. DOYLE. So why were guardrails needed when the FCC opened its proceeding that resulted in the recently overturned net neutrality protection?

Mr. WOOD. I am sorry. You said why were guardrails needed?

Mr. DOYLE. Yes.

Mr. WOOD. I am not sure I completely understand the question. But we do think that keeping the protections we've always had was the right move. I am not sure what guardrails you're referring to in the new proceeding.

Mr. DOYLE. No, in the recently overturned proceeding.

Mr. WOOD. Yes. Well, I mean, again, these are fundamental rights that we think deserve protection and always have had it in some form or another, and so that's why we are looking to restore it now.

Mr. DOYLE. I see my time has expired.

Thank you, Madam Chair.

Mrs. BLACKBURN. Gentleman yields back.

Mr. Shimkus, you're recognized for 5 minutes.

Mr. SHIMKUS. Thank you, Madam Chairman.

Great hearing, interesting issue, contentious views. I want to start with Mr. Schroeder, and I want to, one, thank you for being here, and secondly, I was watching your hands. Were you reading Braille or how was—how did you read to us your testimony? What was going on down there?

Mr. SCHROEDER. Yes, I was. I am reading off of a small Braille device. It's essentially a Braille computer that has my summarized testimony.

Mr. SHIMKUS. Great. And where is the lady who's assisting you through your glasses and the video? Where is actually she physically located?

Mr. SCHROEDER. Amy is in San Diego currently.

Mr. SHIMKUS. Great. Great. So——

Mr. SCHROEDER. I am taking the headphone out so she can talk if you have a question for her.

Mr. SHIMKUS. I hope that you have a good working environment, Amy.

[Laughter.]

Mr. SCHROEDER. You know, one of the things we found when our agents—and Amy was our lead agent and the person that developed a lot of the training that the agents now go through—she is a company employee in San Diego.

But our agents love Aira, as you can imagine. They are paid, as I mentioned. It's largely home-based employment, and as long as they've got a good internet connection, they are able to provide the

support for Aira users, and there's a lot of satisfaction, I know, among our agents and the kind of work that they do from the tedious work of getting somebody through an airport or the very exciting work of actually being able to work with somebody who's touring Paris.

Mr. SHIMKUS. Yes. In your testimony then—you can put her— you can put her down.

[Laughter.]

Mr. SHIMKUS. I don't think I've got questions for——

Mr. SCHROEDER. I'm putting you down, Amy.

Mr. SHIMKUS. Yes. In your testimony you talked about your relationship with AT&T and then the Aira accessibility of Government buildings this week or while there are numerous people who have impaired vision that's on the Hill.

And so it's tied into this hearing. Why do you think you were invited here to testify?

Mr. SCHROEDER. I think Aira has an interesting case to make. We've been clear from the beginning we don't really—as you know if you looked at our company references, we don't really have—we haven't stated a position on this particular topic.

But Aira has a very interesting case to make regarding prioritization, and as I noted it's an upstream priority. So typically when we talk about this issue of prioritized content and access to content, it's usually ensuring that users have access to content, and the discussion tends to revolve around making sure that the content goes downstream in an orderly fashion.

We are the other side of that case. We need to send video upstream and, as you know, often upload speeds don't match download speeds.

And so our critical case to make is that our service can't work if we don't have priority low-latency access. I think we talk about 80 milliseconds is what we try to achieve, or better, of latency because, if somebody is out and about moving, they really do need that instant video feedback that the agent can then provide—that that video in the opposite direction of what we usually talk about in these networking——

Mr. SHIMKUS. Yes. It's excellent testimony, and you can just see someone trying to cross a busy street and then being—feedback is delayed. That's a dangerous proposition to be had.

I just think it really does speak to—it's not as simple as people like to portray this debate.

And I want to go to Mr.—"Ri-*say*-vy"?

Mr. RYSAVY. "Ri-*sah*-vy."

Mr. SHIMKUS. Rysavy. You say it's not a zero sum game. Explain that. Because that's the whole debate. You know, net neutrality— there's winners and losers—Mr. Wood articulates that very—but you say it's not. You can't put it in that—in that——

Mr. RYSAVY. It is absolutely not a zero sum game.

Mr. SHIMKUS. And explain that.

Mr. RYSAVY. The reason is that different applications have different requirements. If I am trying to send a short message to an autonomous vehicle that there's a pedestrian in the road around the corner that the car can't see, that traffic does not have to adversely affect a video streaming application that already has a buff-

er and already has tolerance for delay in how it receives its packets.

Mr. SHIMKUS. So, and then someone else mentioned it's really not a highway. It's a network of networks.

Mr. RYSAVY. Yes.

Mr. SHIMKUS. And so there's other—and Mr. Bennett, in your testimony you talk about how you can manipulate a portion of the network to actually slow up the process where the, quote, unquote, "pie" may get the original one.

Great hearing, Madam Chairman. I wish I had more time, but I don't, and I yield back.

Mrs. BLACKBURN. The gentleman yields back.

Let's see. So Ms. Eshoo, 5 minutes.

Ms. ESHOO. Thank you, Madam Chairwoman.

Again, thank you to the witnesses. I have to say that from the first three, I haven't heard any of you just clearly address why you think paid prioritization is a good idea.

We just heard the exchange with Mr. Shimkus and the witness about different uses of the internet, but you didn't bring up why one case or another should have paid prioritization.

So you know where I am, but I think that your job is to try to dissuade me or bring new facts to the table, and, most frankly, I didn't hear them.

I think that paid prioritization really needs to be examined for exactly what it is. There are many uses on the internet. But, you know, I think that we are going to—here at the committee we have many Members, including myself, that are fighting very hard for rural areas in our country to receive broadband. Some are underserved. Others are not served as they should be.

Put paid prioritization on top of that. How fair is that to those people? You know, the idea is to move it faster, quicker, fairer, expand it so that there's more information to the many in a democracy.

So, to Mr. Wood, can you explain the distinction between—because this term is being thrown around—specialized services and paid prioritization?

And also, you refer to your, in your testimony, to new forms of discrimination, and I think that that is—you know, that could crop up, and if you can expand on that a little I would appreciate it.

Mr. WOOD. Sure. Thank you, Congresswoman.

Specialized services is a term that the FCC has used over the last several years. You might think of it as dedicated access. And so I don't know Aira's business model completely, but a purchaser of a device might not actually be using that device on their own broadband network.

The device might bring the broadband with it, if you will, and that's a way, if there is a need for prioritization and even for the application waiver——

Ms. ESHOO. And that was included in the 2015 rule, right?

Mr. WOOD. It was, and 2010 as well, and this is the kind of thing we've always seen with——

Ms. ESHOO. And the court upheld that.

Mr. WOOD. That's true.

Ms. Eshoo. Very importantly, the courts upheld that. Mm-hmm. I am sorry, go ahead.

Mr. Wood. And then, as to new forms of discrimination, we just believe that the kinds of things Chairman Blackburn was describing—for example, distortion further into the network or especially at interconnection points, as they're called, where the last-mile broadband network receives all this traffic that their users are subscribing for—the users are requesting, and if it can't get to them due to some sort of blockage further up the line or if there is some kind of new form of discriminatory treatment towards the broadband providers and users, we would like the FCC to have the ability to assess that and determine the statute is unreasonable discrimination to assess whether a tactic or a technique is actually benefiting users or hurting them.

Ms. Eshoo. Is there anything that you know of, that you can think of, that makes the case for paid prioritization plausible or acceptable?

Mr. Wood. I mean, as I said, some people might postulate that it would save money for the broadband providers' customers. We just haven't seen that happen, and when you have so few choices among broadband providers——

Ms. Eshoo. Well, how do you save money if you're paying more?

Mr. Wood. Well, you wouldn't be saving money. I think that, you know, sometimes there's a notion that if the edge provider pays, the user won't have to, and what we think of this as is more double charging.

The broadband provider's customer continues to pay for their access, and then the two-sided market, or the handout in the other direction, says now the edge provider pays as well.

So, as I said, I don't think that the ISPs think of this as a way to save money.

Ms. Eshoo. Yes, it's about as clear as fog. Yes.

Well, I just—I wish I heard a very clear case from the wonderful first three witnesses on why paid prioritization is a very good thing for anyone using the internet, and I haven't heard it.

I admire the different services that you have referred to and all of that, but I think that we've got some fog in this hearing, and paid prioritization is paid prioritization.

I don't find anything foundational and positive about it.

Thank you to all of you, and I yield back.

Mrs. Blackburn. The gentlelady yields back.

Mr. Latta, you're recognized.

Mr. Latta. Well, thank you very much, Madam Chair, and thanks for our witnesses. As my friend from Illinois said, this has been a very interesting hearing. I appreciate you all being here to give your testimony today.

Mr. Bennett, if I could start my questioning with you. What are the impacts of traffic management on different applications? And if all video conferencing applications such as Skype or Facetime were in the same traffic lane as general email traffic, how would that impact each service?

Mr. Bennett. Thank you for the question.

The network operators have to manage a pool of resources, and one of the resources that's really critical is what engineers call la-

tency. It's delay. It's how long it takes a packet to get from one point to another.

Low latency is a resource that networks never have an infinite supply of. It always has to be managed.

So it's very important for these video conferencing apps to have low latency because, if they don't, the picture breaks up, you hear, like, dropouts in the audio channel, and the overall accuracy and the feeling of sort of presence of being as if you're in the same room with the person you're talking to, you can't achieve that without very low latency.

Latency doesn't make any difference to email applications. I mean, they're perfectly fine with, you know, and network time is measured in, units of, like, millionths and billionths of a second, and email operates more at the level of, like, minutes and hours.

So, I mean, it doesn't really matter. So when we assign, effectively, low latency to an email packet that doesn't need it simply because we are sending packets in the order they were received or in some other sort of semirandom order, we are wasting a resource.

And so it's actually—I think it's a bit irresponsible to just sort of treat all traffic the same, because that means we are ignoring the fundamental requirements that the users of those services have.

Mr. LATTA. Thank you.

Mr. Rysavy, if I could ask you—in my district and across the country, there's a great deal of interest in manufacturing and other sectors that we see increased efficiency from the Internet of Things.

IOT will be made of next-generation sensors and automated equipment such as drones and robots that can provide real-time and HD video imaging, audio, and other bandwidth-intensive sensing, monitoring, automated processes.

In a world without prioritization, can the Internet of Things become a reality?

Mr. RYSAVY. It would come to a very partial reality. The fact is that the application and quality of service requirements for different applications vary.

So there may be some IOT applications that don't need prioritization. But to expand the number of applications to allow innovators the full range of everything that is possible, many of these techniques of quality-of-service management will be essential.

Mr. LATTA. OK. Well, just a quick follow-up then: So what would that mean for overall U.S. competitiveness in manufacturing?

Mr. RYSAVY. The more artificial restrictions that there are on what kind of applications can be deployed, the less competitive industry will be because you can be assured that other countries who wish to dominate in this space are not going to handicap their technologies.

Mr. LATTA. OK.

Mr. Bennett, going back, if I could, to you, we often hear about how ISPs prioritize packets that manage traffic congestion to complete a user-friendly experience.

However, we see edge providers pay to prioritize search results, advertising, social network feeds, shopping options, et cetera. Given that this form of paid prioritization is happening every day, I would like to understand the impact that it has on consumers.

Mr. BENNETT. Thanks for the questions.

Yes, we can see some of the impact of the prioritization of search results and how the market has changed for product search. For a very long time, Google was the dominant company in product search.

But nowadays more people begin product searches on Amazon than do it on Google, and I don't know exactly why that is happening, but I think it has something to do with the fact that, when you do a Google search, the first few answers you get are all paid ads, and they're not always very relevant, you know, to what you're doing, and they're certainly not as trustworthy as the organic search.

So prioritization, I think, in that sense the company should realize that they've actually hurt their market position by distorting their search results that way and by the fact that the Google search is just not as effective as it used to be.

Mr. LATTA. Well, thank you very much.

Madam Chair, my time has expired.

Mrs. BLACKBURN. The gentleman yields back.

Ms. Clarke, you're recognized for 5 minutes.

Ms. CLARKE. I thank you, Madam Chairwoman, and I thank our expert witnesses for their testimony here this morning.

And given that I also serve on the Small Business Committee, I strongly believe and maintain that the rollback of net neutrality is going to have a hugely detrimental effect on small businesses, and I am not alone in this belief.

Polling indicates that an overwhelming majority of respondents are concerned that the elimination of net neutrality could disadvantage small businesses by allowing big national chains to put their online services in a fast lane.

A number of small businesses in my district back in Brooklyn have been outspoken about this—small businesses like TakeShape and Staffbase—and I could co-sponsor the CRA to reinstate net neutrality in part due to their concerns.

Given that, Madam Chairwoman, I would like to introduce a letter for the record and this record—it opposes the FCC's rollback of net neutrality and it's signed by 800 small businesses.

Mrs. BLACKBURN. Without objection.[1]

Ms. CLARKE. I thank you, Madam Chair.

Mr. Wood, why are small businesses so concerned about the rollback of net neutrality, and why is rolling back the ban on paid prioritization worrying these businesses?

Mr. WOOD. Thank you, Congresswoman.

I think it's pretty clear and simple: They don't want to have to pay extra to deliver their content to their customers.

Now, it's not true that they're not paying. They pay a lot to get their content onto the internet, and they pay their own broadband provider, or sometimes they're even able to build their own connections.

What we are talking about here is then paying my ISP at home separate charge either to cut in line in front of somebody else or

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perhaps just to get the traffic to me in the first place, and it's that extra and, frankly, new toll that I think has small businesses worried.

I saw the poll that I think you're referring to, and it was something like 4 to 1 small businesses opposed to the repeal and worried about paid priority.

A large number of them are uncertain how it would affect their business, so I find it funny that, in the name of creating more certainty, we've actually created great uncertainty for small businesses who thought this was unsettled.

But that's the kind of fear they're facing is, "Are there going to be new tolls and new charges that I must pay just to get my content to my customers?"

Ms. CLARKE. Very well.

I've also been a strong advocate of diversity in traditional media companies, and that's why, along with my colleagues, I've created the Multicultural Media Caucus here in the House.

The sad truth is that diverse voices are seldom truly represented in traditional media but that neutrality can in some ways help fix that problem.

Mr. Wood, why is net neutrality important for groups that are not well represented in traditional media?

Mr. WOOD. Thank you, Congresswoman. I think it's for exactly that reason it does. It doesn't eliminate all barriers, but it lowers the barriers to speaking in one's own voice and getting your story out there.

And so, traditionally communities of color have not been well represented on the airwaves. The internet helps to change that.

Again, I think the notion that some have tried to put forward in this hearing is that prioritization and paid prioritization could help them compete with the biggest content providers, and I just can't see how that would work.

I think if we did allow for paid prioritization, then the traditional media companies would be the first in line and the highest bidders for such slots and that the less well-known and well-established media companies and voices would be pushed to the back of the line.

Ms. CLARKE. Very well, and I remain concerned about the impact paid prioritization can have on innovation and new ideas and on new products.

When a programmer in my district comes up with the next big idea, how can we help ensure her focus is on connecting with her users? And this question is to Mr. Wood and Mr. Schroeder.

Mr. WOOD. I will go just because my mic's on.

I think this is how we can do it, is by preserving the internet as it always has been, where people pay their own broadband connection but then they're not asked to pay an additional toll just to reach the other side of that connection and we have each side of the conversation paying for their connectivity but not this extra toll where the ISP charges in both directions.

Mr. SCHROEDER. Thank you for the question, Congresswoman.

I think for Aira, we are a company that serves a rather small and underserved customer base providing a unique service, right.

So people who are blind or visually compared constitute, you know, maybe 23 million of the population.

The people who need our service don't really have an adequate technology-based solution. What most people would do is try to find a sighted assistant to provide some access to visual information, and there isn't always a sighted assistant around and, frankly, there isn't always a competent sighted assistant around to provide access to information.

Getting to our users has been a real challenge. But to answer maybe the question you didn't ask, but for us, one of the limitations we worry about is—and one of the things we've seen before we had access to the dynamic traffic management that AT&T offers on its essentially high-priority private network—is that our users were not able to get their video through in a way that actually worked, because there were too many lags, too many delays, and too many dropped calls. And so they weren't able to have access to competent assistants using the Aira model.

Ms. CLARKE. I thank you, Mr. Schroeder, and I yield back, Madam Chair.

Mrs. BLACKBURN. The gentlelady yields back.

Mr. Guthrie, 5 minutes.

Mr. GUTHRIE. Thank you very much, Madam Chairwoman, and appreciate the hearing.

And this question is for Mr. Bennett, probably continuing on some of the same theme. I would like to discuss the debate over ISPs taking advantage of their gatekeeper position at the last-mile connection points by prioritizing content delivery for those who pay the most or even holding content hostage, and the counter position that they wouldn't have a viable business model if they did this.

I may be oversimplifying this, but it seems to boil down to questions about relative bargaining positions within edge providers and ISPs and who has the unique advantage in this regard.

So the question: In the development of the internet as we know it today, has there been a need for or practice of paying for priority of content delivery over the last mile?

Mr. BENNETT. It certainly hasn't been a widespread practice, if it has existed at all. There have been certainly a lot of claims that ISPs were holding certain content providers hostage for payment.

In 2014, Netflix accused the major ISPs of doing that to them, but it turns out the network that was actually slowing their traffic down was their transit provider, Cogent. The ISPs didn't really have anything to do with it.

Mr. GUTHRIE. So if it exists, you don't know of it? Is that what you're saying?

Mr. BENNETT. It certainly hasn't been widespread. I mean, in fact, I would like to see more willingness on the part of ISPs to sell prioritized delivery to application providers that had real-time apps, you know, like video conferencing and have never really seen much reason how that would benefit them to sell that service, because it would actually make third parties able to provide voice and face time just as well as the native products sold by the ISPs. This is especially the case at the wireless ISPs.

Mr. GUTHRIE. So who has the stronger bargaining position over the last mile and what if an ISP with less than a million customers

is dealing with an edge provider that has tens of millions of customers for their platform services?

Mr. BENNETT. Well, the day an ISP announces that it's not going to allow Netflix to use its network because, you know, it has some dispute and it's not getting the money, that's pretty much the day that you should short that ISP, as they're—nobody has the kind of bargaining position that Amazon and Netflix and Google have.

Those are regarded as essential services by users of ISPs. There's no way the ISP can mess with them.

Mr. GUTHRIE. Because a lot of my ISPs at the last mile are local—like, utilities, Bardstown City Cable is the ISP. Logan Telephone and Telegraph is the ISP for the last mile for a lot of the areas there that wouldn't have that kind of bargaining power that you're talking about.

In your testimony also, you say sharing is inherent in the internet's design and go on to say access to shared resources of any kind implies the development and implementation of the sharing policy.

Can you elaborate on what options network operators have to manage shared access to a scarce resource? In particular, how does class of service or smart queuing techniques alleviate congestion when network load increases to moderate or high levels?

Mr. BENNETT. Well, the purpose of class of service or type of service in IP is for the application to identify—tell the network what kind of service it needs, if it's a low precedence or whether their focus is capacity or reliability.

The trouble with that is that, typically—and that's used internally by ISPs once they're able to determine what application generated a particular traffic stream, which they can do with a fair degree of accuracy, but it's never going to be 100 percent, especially as new applications emerge that the ISP hadn't seen before and, like, "How do I treat this? Do I treat it just like generic traffic"— you know, which is probably 95 percent or it could be as much as 95 percent of the internet—"or do I give it some sort of specialized treatment?" And the specialized treatment could be, like, it needs to be more urgently delivered than generic traffic, but it also could be less.

And so there's a case to be made for, like, actually—if we can recognize the unique performance characteristics of different streams and then bargain appropriately, for some streams they're going to save money, because if it's like a patch distribution or something that can happen at 3 o'clock in the morning, it doesn't make sense for the ISP to charge a whole lot for that. In fact, it kind of makes sense to give it away for free, because it makes the network work better if all the computers are patched and up to date.

Mr. GUTHRIE. So who manages these techniques? I got about 10 seconds.

Mr. BENNETT. Yes. They're managed by network operation staff at the ISPs, and the tricky part, though, is that the boundary's between different ISPs or different networks—between an ISP and a transit network. And so they operate on the basis of agreements and they typically don't articulate the treatment of non-standard——

Mr. GUTHRIE. Thank you. My time has expired. I yield.

Mrs. BLACKBURN. Mr. McNerney, you're recognized 5 minutes.

Mr. McNERNEY. I thank the Chair, and I thank the witnesses.

As an engineer, I am deeply concerned and troubled by the FCC's decision to repeal the ban on paid prioritization and kick the scraps of net neutrality over to the Federal Trade Commission.

Mr. Wood, does the FTC have the resources to enforce net neutrality?

Mr. WOOD. Thank you, Congressman.

To my knowledge, they do not. They have an enforcement-geared staff, and I think they do a good job but have trouble keeping up with the current caseload that they have, my understanding.

Mr. McNERNEY. I've heard they don't have any network engineers. Is that right?

Mr. WOOD. That's what I've heard as well, yes, Congressman.

Mr. McNERNEY. Well, I am concerned that, without an expert agency with network engineers on the case, we might never know if there are violations of net neutralities.

Back in 2007, we only discovered net neutrality violations due to the work of an engineer working at home on his own.

Might it be difficult for the average consumer to recognize their broadband provider is violating net neutrality?

Mr. WOOD. Yes, Congressman, I think it could, and in fact, with nobody to watch over that process, I do think that would be a problem.

As we've heard, congestion can happen at different places in the internet and different parts of the network. The Netflix and Comcast disputes that Mr. Bennett referenced, a lot of people called their Comcast customer service representatives and said it's not coming through correctly, and the first answer from the company was, "Maybe you should buy a faster speed tier," which wouldn't actually have solved the problem.

So I think even the people who work in the network, either for good-faith reasons or marketing purposes, might not be able to pinpoint where the problem is and then actually help the customer to solve it.

Mr. McNERNEY. Thank you.

About veterans, in response to thousands of constituents who reached to me concerning their concerns about the elimination of net neutrality protections, I had a net neutrality town hall in my district to discuss their concerns.

At the town hall, I heard from a veteran who was very worried about what this would mean for him and other veterans, including their access to health telenet services.

Mr. Wood, given your experience with net neutrality, do you think veterans who need home telehealth services for in-home care should be concerned about the FCC's rollback of net neutrality?

Mr. WOOD. I do, Congressman.

I think what they want is for the service to work, and so as we've heard there could be different use cases, different types of prioritization that the network already does to make sure that all applications can reach their destination.

What I think veterans are worried about overseas is, "I am already paying for my connection, which might be difficult to manage overseas, my family is paying at home"—is there going to be a news hole or a new kind of charge to make sure that traffic can

actually reach his destination, and I think that's where the concern comes from, that this will be a new fee that's ultimately passed on to customers, even if it's the edge provider who is paying it in the first place.

Mr. MCNERNEY. Mr. Schroeder, do you have similar concerns about access with net neutrality protections disappearing?

Mr. SCHROEDER. For the purposes of Aira's technology, again, we are concerned that we have access to a cell network that can deliver our video upstream in a way that is reliable.

I don't know that the end of the Open Internet Order would adversely or would have changed our business model significantly whether or not that order was in place.

I do think it is critical that we ensure that our veterans have access to the kind of service that Aira is providing, and I would say that, given the relatively underserved group that we are reaching out to, my sense is that that's not a group that probably gets priority under any structure.

And so, without a company like Aira really pushing that issue and in our case having a good partner with AT&T in order to allow us to use a priority network, I am not sure that that service would be provided—our business model and our service would be provided—in a way that actually works for people in the real world, as we have to make it work.

Mr. MCNERNEY. Has Aira come out in favor of Mr. Doyle's CRA?

Mr. SCHROEDER. We have not taken a position on any of the bills.

Mr. MCNERNEY. You referred to low latency several times in your testimony. Can you explain what that means?

Mr. SCHROEDER. Yes. Low latency means a connection with no delays or minimal delays. And so, in our case, as we said, our video needs to be able to move through at, you know, what we've estimated currently ideally for Mbps.

We think, with the new glasses that I am wearing—these are called Horizon—by the way, they're actually made almost entirely in San Diego so it's all U.S.-based, we are proud to say—that we may even need a little bit higher bandwidth in order to ensure that the quality of the video that these glasses are able to provide gets through.

And the comment about busy streets and crossing streets: While Aira makes clear that we do not provide information to somebody in the midst of a street crossing because we want them to use their other skills, we do note that people need information very rapidly and very immediately, including out on the street in order to avoid obstacles.

Mr. MCNERNEY. OK. Thank you.

I yield back.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Olson.

Mr. OLSON. I thank the Chair. Welcome to our four witnesses.

This question is for the entire panel. Just go from your right to left. Just give us your thoughts on prioritization.

My hometown of Houston, Texas, was hit by Hurricane Harvey really hard this past August—hit us not once, hit us twice. Some parts of my district had 50 inches of rain—almost 5 feet of rain—in 2 days.

The amazing efforts of the Houston law and local first responders before, during, and after Hurricane Harvey saved thousands of lives.

With prioritization, isn't that important for our first responders? Shouldn't their traffic be prioritized in times of emergency?

Mr. Bennett.

Mr. BENNETT. Yes, Congressman Olson, it certainly should—and, as a former Houstonian who lived through Carla, quite sensitive to, you know, what went on down there recently.

FirstNet is primarily—it's sort of, the value proposition for FirstNet, other than interoperability between first responders, is the ability to get, what do they call it, prioritized quality—preemption and priority.

It's quality, preemption, and priority, so that first responders not only can get a connection during times of emergency, civilians want to use the networks and, you know, call people and let them know they're OK or they're not OK, and call for help, and all that. So there's a lot of pressure on the networks from facilities being down and high usage and so but, you know, we definitely want first responders to have priority access.

Mr. OLSON. Mr. Rysavy, your comments on priority access during times of natural disaster like Hurricane Harvey.

Mr. RYSAVY. Thank you, Congressman, for the question.

Yes, absolutely, that's a perfect example of a situation where certain users such as the first responders do need access. But it's just an example of many, because from there you might consider a surgeon doing remote surgery—they might need prioritization as well. Thank you.

Mr. OLSON. Mr. Schroeder.

Mr. SCHROEDER. I think emergencies provide two interesting examples of why Aira is so critical and why making sure that our information is getting through.

The first one is a lot of the information that is provided during an emergency is inherently visual. There's maps and charts and graphics on television screens that indicate where one is supposed to go, what the storm pattern is, that sort of thing.

Without access to Aira, it is very difficult for a person to get that information in a reliable sense. When somebody is relocated—if you can imagine a person who's blind, they're in an unusual setting—having access to Aira and a reliable visual assistant will allow that person to have better access to the shelter and have, of course, a better experience.

Somebody might say that that's perhaps not critical. I would disagree. I think if somebody has relocated who's blind or visually impaired, they certainly need to be able to access the information around them successfully just like anybody else who's been relocated to that area, and Aira—ensuring that our video gets through is another way that that person is able to have the information about where they are as well as things that they need to know related to surviving that emergency.

Mr. OLSON. Amen.

Mr. Wood, your comments on prioritization during natural disasters.

Mr. WOOD. Certainly. Thank you, Congressman.

Yes, first responders deserve priority during disasters. I would say that was fully permitted under the 2015 rules that have now been repealed.

And the last thing I would want is paid prioritization for first responders. I can't imagine having the ambulance or the fire department pay an additional toll on their way to the emergency.

So I think that draws out the distinction we are talking about here.

Mr. OLSON. Good point.

The final question for you, Mr. Bennett. Your testimony discussed internet optimization, and as you're well aware, we are at the beginning of a huge data boom, another massive data boom.

Could you elaborate on possible tools that could be used in the future to help further efficiencies, to optimize the internet traffic, and also what role does AI play in the future?

Mr. BENNETT. AI is going to be essential, I think, to identifying traffic streams and mapping them to applications and determining what kind of service they need.

The capability to do that has sort of increased an awful lot in network routers over the years and, well, it's sort of hard to draw the line between sort of better programming and AI.

I mean, it definitely leans toward the side of AI, the kind of intelligence that networks have to have these days.

Mr. OLSON. My time has expired.

I yield back. Thank you.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Engel, 5 minutes.

Mr. ENGEL. Thank you, Madam Chair and Ranking Member.

When Mark Zuckerberg was before our committee last week, one of the things I asked him was about foreign influence on our democracy.

In the FCC's docket that rolled back the ban on paid prioritization and the other net neutrality protections, Americans' identities were stolen and used to comment in support of Chairman Pai's rollback of net neutrality.

It seems like another attempt at sowing division.

Mr. Wood, have you received any of these fake comments filed in the FCC's docket?

Mr. WOOD. Thank you, Congressman.

Have I seen them? Is that the question?

Mr. ENGEL. Yes.

Mr. WOOD. I have seen some sampling of the 24 million comments, yes, and I know that there have been allegations about fake comments coming from foreign sources and from all sides.

Mr. ENGEL. Do you think the FCC has done enough to address the fake comments in the record?

Mr. WOOD. No, I certainly don't. In fact, the attorney general of New York has tried to launch an investigation on behalf of New York State residents whose identities were stolen and inappropriately used in the proceeding.

And I think it's fair to say the answer they've gotten from the FCC has been something of a shoulder shrug to this point. So I don't think the FCC has either used all of its own tools or cooper-

ated strongly enough with other law enforcement agencies who want to look into this.

Mr. ENGEL. What else should they have done?

Mr. WOOD. Well, I mean, I think it's a good question. We want to have maximum participation in these public decisionmaking processes.

So I don't know if there's much they could have done to stop the inflow of any fake or fraudulent comments. I've heard that even several Members of Congress had their names used, including their street addresses. So it wasn't just a matter of filling in a fake name.

I don't know what more they could have done at the beginning. But I do think they should have paused and considered what to do about the bad comments flowing into the record during the process and then maybe should have taken longer to consider what to do with them before voting.

Mr. ENGEL. Would you anticipate legal challenges to the FCC's order repealing net neutrality based on the fake comments?

Mr. WOOD. Well, we have actually filed suit. Something like 23 attorneys general, a dozen or more public interest organizations like ours, and internet companies as well, and also some local—for example, Santa Clara County and the California Public Utilities Commission.

I think that will be part of the case. I can't tell you how much it will be part of the arguments or the judge's response to it.

Mr. ENGEL. Mr. Wood, let me stick with you.

You testified that getting rid of paid prioritization would radically change the internet. You said that the ban only prevented ISPs from favoring traffic in exchange for payments from third parties or to benefit an ISP's affiliated video or voice offers. But it did not ban user-directed traffic.

So can you expand on that and explain a little more about how user-directed traffic works?

Mr. WOOD. Certainly. I hope so. The internet protocols that already manage these kinds of different needs for different types of applications, that goes on today. I think all the witnesses have spoken about it to some degree, and that kind of process was not prohibited by the paid prioritization ban.

All that the rule prohibited was having an edge provider or some other third party come in and try to alter that natural balancing that goes on.

If the balancing couldn't happen in what I would call a neutral fashion, with the protocols just deciding which applications need priority at that particular point in time, then the user could also pay their broadband provider, and we have more comfort with that because then the internet user remains in control of how their connection is being used, so which content they can get and also which type of application and services they might need to or choose to prioritize at a particular point in the day.

Mr. ENGEL. OK. Well, thank you very much.

Thank you, Madam Chair. I yield back.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Bilirakis, 5 minutes.

Mr. BILIRAKIS. Thank you, Madam Chair. Appreciate it.

I want to thank the panel for their testimony as well.

Mr. Schroeder, as stated in your testimony, the speed of your service is near instantaneous, and when you discuss how the service is used not only for work-related tasks but helping people navigate city streets, speed is, clearly, a requirement. Isn't that the case?

Mr. SCHROEDER. Yes, Congressman Bilirakis.

Mr. BILIRAKIS. It seems your partnership with AT&T is central to your service. Isn't that the case?

Mr. SCHROEDER. It is a very important element, yes.

Mr. BILIRAKIS. Can you describe how the user experience would be different if Aira did not have this partnership and had to compete equally with all other internet traffic?

Mr. SCHROEDER. I can, because we rolled out the relationship with AT&T's Dynamic Traffic Management Network about over the last four to six months.

Prior to that time, we got many complaints from our users, and I am an Aira user myself and I also experienced many dropped calls, many significant delays in video, many instances where we had an audio connection with the agent but no video and they did their best using GPS and other sensor data that we were able to get upstream. But the lag in video created not only trouble for our business model, because we are a service that people subscribe to, but more important created challenges for people who are blind who, in the midst of needing a sign read to them, needing to make a decision about which direction to go, needing to find that last— we often—you talk about the last mile, we often talk about the last 20 feet, trying to find the right door. And oftentimes that's when the video would, unfortunately, kick out, and so just when you needed the information most.

I know and I know our users experienced what the network situation was like before we had access to a priority network, and it was not a good experience.

Mr. BILIRAKIS. So you just described the latency consequences?

Mr. SCHROEDER. That's correct.

Mr. BILIRAKIS. Yes. OK. Very good. Thank you.

Next question: As a relatively new company, did you find it difficult to get a partner that would provide the prioritization services that your company needs to operate?

Mr. SCHROEDER. You know, sometimes I am a little bit embarrassed. Aira gets a lot of attention. I think a lot of people find what we do to be quite remarkable and quite amazing.

We actually had no trouble finding interest among carriers to work with Aira and to allow us to or to encourage us to work with their cell networks.

AT&T was the company that came through with the best partnership and really showed the most interest in giving us opportunity to work with their priority network as well as, as I mentioned in my testimony, providing support for getting Aira into the hands of college students and in working with us in designing some of the technology that we are using, for example, to get access to prescription medication, which is one of the highest use cases that our Aira users often need to ensure that they're taking the right medicine.

Mr. BILIRAKIS. That's great.

I want to commend you for working with our veterans as customers, but also as employees. But I also want to give you an opportunity, because I do have some time, to describe how Aira works and how beneficial it is to your customers, if you please. And so, if you can elaborate a little bit more on it, because it is fascinating and it improves a person's quality of life.

Mr. SCHROEDER. Thank you for that, Congressman Bilirakis, and I appreciate your support as well. We have so many wonderful stories from our Aira users who use the service, of course, in critical ways like navigating the Boston Marathon—which, trying to move among runners, as you can imagine, is a very dicey proposition, especially in the weather conditions they had yesterday, and it speaks to the need for having a very strong network with low latency available to them.

We've also had individuals who have spent a few hours working with an agent putting IKEA furniture together, and I don't know if I should mention a specific company. But I think we all know how challenging following some of those visual directions if you can see can be.

Many of our users have found Aira to be extraordinarily helpful in navigating technology. There's a lot of great technology, such as what I am using here with this Braille device that makes information available to blind people. But it sometimes doesn't work. It sometimes breaks down, and when it breaks down we are suddenly—we are confronted with a blank screen—blank to us because we can't see it—and being able to quickly grab an Aira agent via the smart glasses and application allows us to have access to what is on that screen so we can hopefully save our work and be able to continue to be productive.

Oftentimes in the past—I know the time is up—but oftentimes in the past, it would take several minutes or maybe hours to find somebody sighted to come and help figure out what was on that computer screen. Now we've got that instantaneous with Aira.

Mr. BILIRAKIS. Well, thank you very much. And I know it's very beneficial to our constituents. I appreciate it, and I yield back, Madam Chair.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Flores.

Mr. FLORES. Thank you, Madam Chair.

Madam Chair, I would ask to enter into the record an article written today by Roslyn Layton of AEI that's called "Prioritization: Moving past prejudice to make internet policy based on fact."

Mrs. BLACKBURN. Without objection.

[The information appears at the conclusion of the hearing.]

Mr. FLORES. Thank you.

Mr. Bennett, talking about 5G for a minute, the next leap in technology for wireless, does China have a ban on paid prioritization?

Mr. BENNETT. Not as far as I know. The telecom carriers in China are state-owned enterprises.

Mr. FLORES. Right.

Mr. BENNETT. And they're pretty much able to——

Mr. FLORES. How about Japan?

Mr. BENNETT. Japan, I don't think it does.

Mr. FLORES. They don't? And South Korea? Do they have a ban on paid prioritization?

Mr. BENNETT. No, definitely not. South Korea offers all kinds of gradations of internet.

Mr. FLORES. So we talked about discrimination against rural communities. Let's assume this fact pattern for a minute. You have got an ISP that has an internet pipe going into a rural community. That rural pipe drives or carries the traffic for a new 5G network that we have in that rural community, but it's a limited-size pipe.

So you're going to have 5G traffic. You're going to have RS traffic going over it. You're going to have FirstNet going over it, hospitals, schools, and then on a Saturday night, 80 percent of the traffic is going to be coming through because of video.

If you don't have paid prioritization, what happens to everybody's traffic under that scenario?

Mr. BENNETT. Well, if you don't prioritize, then what happens is when network load increases and latency increases, and it's sort of every app is affected to some degree, and the more sensitive apps are affected more seriously.

Mr. FLORES. OK.

Mr. BENNETT. So I think one of the implications is that, for rural users, is if you can't get consistently low latency for Skype, then you're going to have to keep on paying for an old-timey telephone connection because your Skype is just never going to be reliable.

Mr. FLORES. And Mr. Schroeder, what would that do to your Aira users, if you're in that community without a paid—again, there's no paid prioritization.

Mr. SCHROEDER. Yes. We do have users in the rural areas, and there is often a struggle to ensure that we've got good network access for those individuals. That is something that we certainly look forward to, further network development.

Mr. FLORES. And so, Mr. Woods talked a lot about discrimination against different populations because of a paid prioritization. It sounds to me like the opposite is true.

If you have a ban on paid prioritization, it would discriminate against your population of sight-limited and also veterans. Does that make sense?

Mr. SCHROEDER. We don't know——

Mr. FLORES. Again, using the same example.

Mr. SCHROEDER. Congressman, we don't know whether that's true or not. But we suspect—what we do know is that having access to a reliable network is critical, and in this case we are able to use a priority network for that purpose. So that is helping.

Mr. FLORES. OK. And so, but if you didn't have access to that paid priority network, then you wouldn't be able to have that service with the low latency?

Mr. SCHROEDER. Our service certainly suffered prior to that access.

Mr. FLORES. OK.

Mr. Bennett, in order to offset that—again, you have got this community, it's got a new 5G network, it's got limited last-mile capability—who pays to expand the capacity?

Mr. BENNETT. In the absence of anyone else coming up with the desire to do that, it's going to be the carrier.

Mr. FLORES. OK. And so then——

Mr. BENNETT. Who is going to pass the cost on to the consumer.

Mr. FLORES. Right. So essentially, if you don't have paid prioritization, then everybody pays to offset the latency issues that are introduced because of a ban on pay prioritization. Is that correct?

Mr. BENNETT. Absolutely, just as today the people who don't use Netflix pay for the capacity upgrades that enable others to use Netflix.

Mr. FLORES. OK. So, again, the cost is being socialized for the people that want to use lots of bandwidth across the entire population, even those who don't use the bandwidth.

That doesn't sound fair to me. I mean, we have a population that pays for priority TSA pre-check, pays for toll lanes, pays to use UPS instead of the mail service, or pays for priority mail.

It seems to me like folks ought to pay for their fair share.

Madam Chairman, I yield back the balance of my time. Thank you.

Mrs. BLACKBURN. The gentleman yields back.

Mrs. Brooks, you're recognized 5 minutes.

Mrs. BROOKS. Thank you, Madam Chair.

I would like to just clear up and make sure we are all on the same page relative to FirstNet—FirstNet, obviously, being the network that has been created most recently to ensure the public safety has the ability to communicate and gets priority in the case of emergencies and disasters and is now just beginning to be built out across the country and so forth.

But there is a ban on paid prioritization involving FirstNet, is there not? I am a little bit confused.

Mr. Bennett.

Mr. BENNETT. There's not. FirstNet is a special-purpose network that's separate from the regular—or is sort of a supplement to the regular mobile network.

But the preemption of the—or the relocation of the old Title II regulations that were enacted by Chairman Wheeler means that there is no ban on paid prioritization for anyone.

Mrs. BROOKS. OK. And so how is it that we can ensure that FirstNet, for instance, will receive that priority in an instance of a disaster?

Mr. BENNETT. Well, FirstNet is designed to do that. So if it doesn't do that, then it's failed to meet its primary goal, which is quality, preemption, and prioritization.

But the thing that worries me about FirstNet is, because it does so many things that fall outside the realm of what the traditional net neutrality advocates have demanded, what's to prevent one of them—Mr. Wood's organization or some similar organization—from simply filing a suit against FirstNet for violating net neutrality?

Mrs. BROOKS. Mr. Wood, you brought this up a little bit. Can you please comment on this? Because I do want to make sure that we all are on the same page when it comes to the importance in the preemption of FirstNet.

Can you please comment?

Mr. WOOD. Certainly, Congresswoman.

I think my earlier answer was that, yes, emergency services deserve priority. They could have had that under the rules that have now been repealed.

Mr. Bennett is correct that they don't face any such rules today because there are no rules in place at the moment, or at least there won't be when the rule changes take effect here in the next few weeks.

But, again, I think what we keep missing is the distinction "prioritization" and "paid prioritization." And so, again, the last thing I would want is for first responders to have to pay to prioritize their traffic during times of emergency. They were able to prioritize for any kind of public safety or emergency use case under the old rules, and I think that's what should continue now.

Mrs. BROOKS. But that's not being contemplated right now, is it?

Mr. WOOD. I think what's being contemplated is FirstNet is actually designed to be a prioritized network for first responders, and that would not have violated the 2015 rules that have now been repealed. It's not a violation of anything now. It's nothing that we would fight against.

We have three lawyers, so we are not really in the business of filing more lawsuits than we need to.

Mrs. BROOKS. OK. So you have no plans on filing any lawsuits?

Mr. WOOD. Certainly not.

Mrs. BROOKS. OK.

Mr. BENNETT. Could I——

Mrs. BROOKS. Yes, Mr. Bennett.

Mr. BENNETT. Can I add something to that?

Mrs. BROOKS. Yes.

Mr. BENNETT. Mr. Wood says that paid prioritization is not part of FirstNet. But first responders pay to be part of FirstNet.

They pay to use—it's not a free service, right. So it's partially paid for by fees that States and municipalities give up to be part of that network. And so then, once they've paid those fees, then they get all the prioritization they need.

Mrs. BROOKS. So how will a ban on paid prioritization implicate FirstNet, Mr. Bennett?

Mr. BENNETT. I am not sure that it would for the use of the primary channel. But first responders—FirstNet is designed actually use bandwidth that's available over regular commercial networks as well when, you know, when it needs to.

And so I think there could be scenarios in that secondary usage of the other channels that could subject FirstNet, certainly, to a challenge.

Mrs. BROOKS. Very briefly, Mr. Rysavy, shifting gears a minute, can you comment on how 5G will inherently prioritize traffic to handle a wider range of applications than 4G?

Mr. RYSAVY. Thank you for the question, Congresswoman.

5G is being designed with a very sophisticated quality-of-service architecture with which traffic flows can be managed not only for priority but also for latency, possibility of packet loss, guaranteed bandwidth, and so forth. So you really need to manage all of those aspects to be able to provide services with exactly the type of performance that they need.

Mrs. BROOKS. Thank you. My time is up. I yield back.

Mrs. BLACKBURN. Gentlelady yields back.

Mr. Doyle just told me that baseball players get priority.

[Laughter.]

Mrs. BLACKBURN. And so he favors priority.

Mr. DOYLE. Good ones. Good ones that are on the committee.

Mrs. BLACKBURN. So you are—you're recognized.

Mr. RUIZ. Given that I am the only other Democratic Member here and that I've had my share of splinters collected, sitting on the bench, I appreciate that, Coach Doyle.

Thank you. As a physician, I think we have obligation to make sure that we are using the internet and technology to help improve the public's health.

The FCC's 2015 net neutrality protections actually came up with a very targeted way to ensure specialized services like telehealth and public safety technology are allowed to thrive.

But I am concerned that the current FCC has done the opposite by abandoning any protections that prohibit big corporations from paying for their services to be prioritized over these telehealth-type services.

So, with that in mind, I would like to introduce a letter for the record from the American Medical Informatics Association that expresses these concerns.

Mrs. BLACKBURN. Without objection.

[The information appears at the conclusion of the hearing.]

Mr. RUIZ. Thank you so much. So my first question is for Mr. Wood. It's very simple: Is there anything in the FCC's most recent net neutrality order that will ensure, guarantee hospitals, community health clinics, and local police departments won't just get pushed into slower lanes because they can't afford to bid against the big megacorporations down the road?

Mr. WOOD. Thank you, Congressman.

Not to my knowledge. I know that the current order basically took away all of the traffic management rules and guidelines and left it to the ISPs. It has some transparency obligations that they face, but nothing that would speak to their ability to either charge for priority or not.

Mr. RUIZ. Yes. So there are no safeguards to guarantee that these vital public health services are protected and not marginalized for profit motive?

Mr. WOOD. That's right. To my knowledge, there are no safeguards and basically this FCC has washed its hand of the business and said that they are not going to have any rules whatsoever when it comes to what ISPs try to prioritize or not.

Mr. RUIZ. OK. And what would you do to ensure those safeguards?

Mr. WOOD. Well, we have supported the Congressional Review Act resolution of this approval to restore the 2015 order. We feel it's important to restore the entirety of the rules that were lost but also the FCC's ability to investigate if something like that were to occur.

So sometimes this is talked about in a competition framework, and that matters. But we would certainly want to FCC to have the ability to investigate if it were a certain kind of telemedicine or

health application being discriminated against, even if that were not to favor another telemedicine application but simply were a bad choice made by the cable or phone company.

Mr. RUIZ. OK. And, as a lawyer that follows net neutrality closely, can you explain what it means that the FCC's original net neutrality protections treated telehealth as a specialized service? What does that mean?

Mr. WOOD. Well, it means that they were allowed to be treated as specialized services. I would note that I think many telehealth applications can and do run over the open internet.

So it's not the case that every health application, or every medicine application, even, has to be treated as a specialized service.

I don't know if the word has a lot of meaning for folks. I sometimes think of it as dedicated capacity. And so, if you have an application that does not fit well on the open internet, it needs additional protections, then it could be treated as a specialized service—again, usually paid for by the person who has the arrangement with the ISP.

So not necessarily this additional kind of toll, where they're paying twice, both for their own connectivity and for priority in the last mile, but simply arranging their own kind of delivery privately.

Mr. RUIZ. One of the biggest challenges that we have is in rural America, where you don't have population centers that can access the infrastructure for broadband and other things, even for commercial use. These are exactly the locations where we want to promote telehealth, because they need access to doctors and health care services.

Do you think it's a valid concern that, without the strong net neutrality protections, we might undermine innovation in the medical space and elsewhere?

Mr. WOOD. I do, Congressman.

I think that the genius of the internet has been that application makers can come up with their ideas and not have to pay an additional toll to bring them to market or to get them through that last mile to the user.

And so, when you do have a small ISP—I have the same concerns, not just that the small ISP might serve as a bottleneck but, if they were really were at a bargaining disadvantage with the biggest edge providers, then perhaps that content would be prioritized rather than the small application makers or innovators.

Mr. RUIZ. We are starting to see a lot of tech-medicine-type opportunities for people in rural areas that haven't been served for mental health services.

And so now you're seeing folks on their phones or their pads, their computers being able to actually have counseling for the first time and be connected with other addiction services groups to provide social support networks to get the care that they need.

And so I am just concerned that this is going to inhibit that progress that is being made out there.

Thank you very much.

Mrs. BLACKBURN. The gentleman yields back.

Mr. Johnson, 5 minutes.

Mr. JOHNSON. Thank you, Madam Chair, and thank you, gentlemen, for joining our panel today.

Mr. Schroeder, a lot of parties paying attention to this hearing have pushed the idea that we don't need to worry about whether an application like Aira could avoid a paid prioritization ban in the future, since past net neutrality attempts have always included an exception for specialized services.

Setting aside the problem that past performance does not predict future results, that is actually incorrect. The 2015 Open Internet Order specifically rejected the, quote, "specialized services," unquote, carve out, providing instead an exception for "services that are not broadband internet access service unless a service that is not broadband internet access service is provided in a manner that undermines the purpose of the open internet rules."

Now, do you understand what that means? Because nobody else understands what that means.

Mr. SCHROEDER. No, Congressman. The way you phrased it, I can't untangle that thicket.

Mr. JOHNSON. Yes. Well, nobody else can either. So Mr. Rysavy, your thoughts on this. Would that definition give you any confidence that some of these services we are talking about would meet the FCC's approval?

Mr. RYSAVY. Congressman, thank you for asking.

No, not at all. The exception for specialized services is ill defined and certainly does not foster innovation or any confidence in moving forward with such applications.

Mr. JOHNSON. All right. Well, thank you.

You know, the devil is in the details. This is one we need to make sure we get right, or a paid prioritization restriction could do some real harm.

Mr. Wood, moving on to you, you seem to indicate in your testimony that broadband was considered a Title II service until the Bush FCC tinkered with its classifications.

What you didn't mention, though, was that the Obama FCC agreed with that classification of broadband as an information service and left it there in its first attempt at net neutrality rules in 2010, and even the 2015 Open Internet Order acknowledged the long track record here.

It spelled out all the history and tied the determination that broadband was an information service all the way back to the computer inquiries that the FCC had decided over 50 years ago.

The Commission was very specific that it was changing its mind and disavowing all the previous precedent to reclassify broadband into a Title II telecommunication service.

So do you disagree with the determination by Chairman Wheeler that, before 2015, broadband had always been an information service?

Mr. WOOD. I don't know that he said it precisely that way, but I do disagree with that phrasing.

Before 2015, you mentioned the first Obama administration attempted at neutrality rules. Like the rules that were adopted at the tail end of the Bush administration, those were struck down in court. So there's a reason that we went back to the drawing board and talked about it again.

The dispute here is not so much whether broadband was an information service but whether internet access was, and there are two parts of that. There's the connection that gets you online. Then there's the service or the content you interact with once you're there.

So there has been some historical dispute about whether something like AOL, for example, was an information service. I would say that it was. It was allowing you to browse the internet, but only once you got to that site using your phone connection.

And what we say is that from, really, before 2002 all internet access, that physical connection was Title II. The FCC started to change that and said that access over a cable line could be considered an information service, and that's when the attempts to prevent discrimination on those lines started to fall down in court. So that's why the FCC returned to what we see as the rightful legal definition.

Mr. JOHNSON. Got you. OK.

Mr. Bennett, most of us subscribe to mass-market retail broadband. This means that, rather than each of us having a dedicated pipe to just our home, we are sharing bandwidth with all of our neighbors who also subscribe to that same service.

So, if everyone on my street is streaming videos in the evening to broadband speeds, I am getting what might be slower than I would experience at another time when not as many users are on the connection.

So here's my question to you: What happens if there's an emergency that I need to call 9-1-1 on my voice over IP-enabled phone? Since that call goes over my broadband connection at some point, will it also be caught up in that video congestion? Will my 9-1-1 call be degraded so someone can watch a cat video?

Mr. BENNETT. The short answer is yes.

Mr. JOHNSON. OK. That's about all I can ask for.

Madam Chair, I yield back.

Mrs. BLACKBURN. The gentleman yields back.

Mrs. Walters, 5 minutes.

Mrs. WALTERS. Thank you, Madam Chair, and thank you, witnesses, for being here.

When talking to my constituents back home about tech issues, one of the questions I've been asked is how prioritization could impact them.

I know some of my colleagues have covered a couple of these issues, but I would like to ask a few questions that some of my constituents have been asking me.

One thing that comes up is the issue of degradation and internet traffic management. Some people have expressed concerns that prioritizing certain traffic over other degrades the traffic that is not prioritized.

Mr. Bennett, in your testimony you mentioned the Differentiated Treatment of Internet Traffic report, which, quote, "demonstrates that traffic differentiation is not a zero sum game."

Could you explain what that means for the average internet consumer?

Mr. BENNETT. Yes, I can.

I was a member of the committee that wrote that report. The point is that, because applications are not all created equal, a sort of a theoretical or a literal degradation of an individual piece of information by a millionth of a second or so may qualify in a legal sense as a degradation.

It's not a degradation that the consumer will perceive. And so, given that we are placing so much importance on polling and—you know, which is sort of a question of measuring perception—the question is whether there's a perceptible degradation, and in that sense prioritization is certainly provably empirically without a doubt unquestionably not a zero sum game.

Mrs. WALTERS. OK. Thank you.

And Mr. Rysavy, in your testimony you talked about network slicing and its relationship to quality-of-service management. Can you explain the concept of network slicing in layman's terms and how it affects the average consumer?

Mr. RYSAVY. Thank you, Congresswoman, for the question.

Network slicing is an architectural aspect of 5G. Basically, it's a way that the network will present different faces for different usages.

So, in theory, an operator could develop a slice for autonomous vehicles, another slice for a factory automation, and so forth, and each of these will require very specific quality-of-service requirements among which traffic prioritization is essential.

What it translates to the user is that, with network slicing, they will see a wide range of new, innovative services coming to market.

Mrs. WALTERS. Thank you.

And throughout this hearing, there's been a discussion about the different forms of prioritization, and I think we can all agree that there are instances where certain traffic has to be prioritized over others, like the example that we've been hearing a lot lately is prioritizing 9-1-1 call over a cat video.

Mr. Bennett, can you talk about types of bad prioritization, including types we should actively prevent?

Mr. BENNETT. You know, I think any sort of negative prioritization that's intended to impair the performance of a competitive product to the carrier is something that should be looked at with suspicion. But I think it's sort of covered under general antitrust law.

I am not a lawyer like Mr. Wood is, so I can't really justify that. But it's my sense, the way it's been explained to me, that the violations that we are concerned about are essentially already prohibited under sort of the general laws of regulating business in the U.S.

Mrs. WALTERS. Mr. Wood, would you want to add anything to that?

Mr. WOOD. I could. I think the antitrust could be a remedy for some competitors, say, if Comcast decided to block Netflix. I don't think it would be a very useful remedy in all instances, especially if there were smaller video providers who were suffering from that kind of blockage or deprioritization, and I think all we have to do is look at cable TV, where you don't have some kind of common carrier mantra and framework.

You know, cable TV is not illegal under the antitrust standards. Cable providers do pick and choose which content to show you.

The question is, should we have no safeguards whatsoever and make the internet more like cable TV or should we have the same kind of two-way open transmission network we've had that lets people go to any site of their choosing.

Mrs. WALTERS. And what should Congress consider doing to prevent these types of prioritization activities from occurring? And Mr. Bennett and then Mr. Wood, if you'd like to join in.

Mr. BENNETT. I would rather that Congress adopt a generally permissive attitude. There's been so much demonization and so much sort of emotional rhetoric and spin and framing in this discussion that I think we've just sort of—we've gone way overboard on the side of caution.

So let's let a few things happen. Let's allow some experiments like Aira to take place and examine the marketplace and then, if something is going on, then step in and correct, but preemptively allow people to innovate.

Mrs. WALTERS. My time is up.

Mrs. BLACKBURN. The gentlelady yields back.

Mr. Costello for 5 minutes.

Mr. COSTELLO. Thank you.

Mr. Rysavy, I enjoyed reading your testimony——

Mr. RYSAVY. Thank you.

Mr. COSTELLO [continuing]. And found it very helpful. I want to cite something and ask you this question. Mission critical use-case-model-type analysis that you provided, you state, "This category of 5G application will depend on the ability to deploy traffic prioritization."

Can you just briefly explain why prioritization will be necessary for 5G? Is it necessary, and if so, why?

Mr. RYSAVY. Thank you for the question, Congressman.

Yes, prioritization is an absolutely essential aspect of 5G in enabling new use cases. The whole motivation for investing hundreds of billions of dollars in 5G networks is to expand what can be done with wireless technologies, and being able to support mission critical applications is going to be a great expansion of capabilities compared to 4G.

Mr. COSTELLO. And along that line, and I think the terminology here—I think everybody supports net neutrality, broadly speaking—certain types of paid prioritization, I think, obviously do fall under FTC and are anticompetitive.

When you speak about prioritization here, what you're speaking about is organizing slices based on the type of data and what it's used for. Is that correct?

Mr. RYSAVY. That is correct.

Mr. COSTELLO. Is there a better way for you to—would you embellish on that, if need be, or was that——

Mr. RYSAVY. No, the whole point is to recognize that different types of applications have different requirements. Some may need very high bandwidth but can drop a lot of packets because it won't impact the user experience. Others might be very low bandwidth, but the reliability of information carried might be absolutely crucial.

Mr. COSTELLO. You go on to say, "But unprioritized and competing with other traffic, the latency ... can be 10 times higher, for example," and then you go on. And what you're saying there, I believe, is that, if we don't have prioritization, that you will end up across the board generalized with slower data getting from point A to point B. Is that correct?

Mr. RYSAVY. Yes. The point I am making is that, if you have to treat every packet equally, that you will end up degrading the average quality of experience across the base of applications.

Essentially, prioritization is an extremely powerful tool for network management, and to ban it really undermines the value of these networks, moving into the future.

Mr. COSTELLO. Mr. Wood, what's your response to that?

Mr. WOOD. I think it's just where we began, Congressman: that we haven't called for a ban on prioritization done in a neutral fashion to make sure that applications work. We've called for a ban and the rules had a ban on paid prioritization, meaning that the edge provider, the app maker, whomever we want to think——

Mr. COSTELLO. The one you have the content associated with it. But don't you agree that the FTC already has jurisdiction over that and is able to enforce?

Mr. WOOD. Well, the FTC might have jurisdiction, or DOJ might if we could make it come to——

Mr. COSTELLO. Well, they do or they don't, don't they?

Mr. WOOD. Well, they have jurisdiction over certain kinds of anticompetitive conduct. They don't have jurisdiction if my own home connection is suffering because I can't reach the content that I want, and I am focused on the internet user, not just this battle between Comcast and Netflix or any other two large providers.

Mr. COSTELLO. Isn't in the interest of the company to make sure that the user does have access?

Mr. WOOD. Well, I think what we are talking about today, though, shows that there are use cases for prioritization. So they have general interest in making sure that content is available, but that they might then pick and choose which content is available at which terms for people who pay more.

Mr. COSTELLO. I had another question. This is tangential, I apologize. But the fake comments—what is your—I mean, what is a fake comment?

Mr. WOOD. Well, I think there are different kinds one could describe as less valuable. We certainly think the petition——

Mr. COSTELLO. But isn't the FCC able to sift through that and determine what's valuable and what isn't?

Mr. WOOD. Well, I think they said they are not going to decide what is fake and what isn't. So, to me, something that is obviously fake or fraudulent is somebody using——

Mr. COSTELLO. But what's fake?

Mr. WOOD. Somebody using somebody's else identification and name and address to put a comment in.

Mr. COSTELLO. But the content, isn't it about the content and not who says it?

Mr. WOOD. Well, I do think people have a right to not have things said in their name. So, if somebody put a comment in for you supporting Title II, you might care.

Mr. COSTELLO. People say that I—fair point. But ultimately, though, the FCC would be looking at the content of the comment, not who said it. Wouldn't that be accurate?

Mr. WOOD. I would hope they would look at the content, but I think it matters who said it too because people have a right to speak in their own name and not have others speak for them or pretend to speak for them.

Mr. COSTELLO. But the FCC wouldn't decide something one way or the other just because a specific person said it or didn't say it. Wouldn't that be correct?

Mr. WOOD. That's right, and I think that they still have an obligation to make sure their record isn't tainted by people basically engaging in identity theft in order to make comments that are not actually their own.

Mr. COSTELLO. Sometimes we probably wish people wouldn't taint our comments too.

OK. Thank you. I yield back.

Mrs. BLACKBURN. The gentleman yields back.

Seeing that there are no further Members——

Mr. DOYLE. Madam Chair?

Mrs. BLACKBURN. Yes, sir.

Mr. DOYLE. Can I ask unanimous consent, in addition to the letters from pediatricians, telehealth experts, small businesses, and others supporting a ban of paid prioritization, I have one additional letter from the Consumers Union that I would like to introduce onto the record.

Mrs. BLACKBURN. Without objection.

[The information appears at the conclusion of the hearing.]

Mr. DOYLE. Thank you.

Mrs. BLACKBURN. Yes. You all have been gracious with your time and with getting your testimony in.

Before we conclude, I do want to submit for the record, and ask unanimous consent to do so, tweets of CloudFlare CEO Matthew Prince; a report by Richard Bennett, "Designed for Change"; a report by BITAG; Daniel Lyons' article; your comments, Mr. Rysavy; a report by Mr. Rysavy, "How Wireless is Different"; and an article by George Ford.[1]

[The information appears at the conclusion of the hearing.]

Mrs. BLACKBURN. I will remind our Members that, pursuant to committee rules, they have 10 days to submit questions in writing to you, and you all will have 10 days in which to respond.

There being no further business to come before the committee, we are adjourned.

[Whereupon, at 12:26 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

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[1] The information appears at the conclusion of the hearing, except for the Bennett, BITAG, and Rysavy reports and Mr. Rysavy's comments, which have been retained in committee files and also are available at *https://docs.house.gov/Committee/Calendar/ByEvent.aspx?EventID=108168.*

INC◉MPAS
THE FUTURE OF COMPETITION

April 16, 2018

The Honorable Marsha Blackburn
Chairman
Subcommittee on Communications and Technology
Committee on Energy and Commerce
U.S. House of Representatives
2266 Rayburn Building
Washington D.C., 20515

The Honorable Michael Doyle
Ranking Member
Subcommittee on Communications and Technology
Committee on Energy and Commerce
239 Cannon House Office Building
U.S. House of Representatives
Washington D.C., 20515

> **Re:** **Communications and Technology Subcommittee Hearing on April 17, 2018
> on Internet Prioritization**

Dear Chairman Blackburn and Ranking Member Doyle:

INCOMPAS, the internet and competitive networks association, supports the open
internet protections that the Federal Communications Commission adopted in 2015. No
blocking, no throttling, no paid prioritization, reasonable interconnection practices, and no
unreasonable conduct that harms the openness of the internet are the cornerstones of net
neutrality policy. Without *each* of these protections, the U.S. does not have an open internet, and
consumers will pay more for slower networks and have less innovative online options available
to them.

The Subcommittee's hearing on Tuesday presents an opportunity to further explore why
preserving a free and open internet for American consumers is critical for the economy and is
strongly supported by the American people. Indeed, last year during the FCC's proceeding,
INCOMPAS conducted a survey of voters (see attachment) wherein 86% of all voters agreed that
ISPs should treat all websites and content equally. Voters also understood that by repealing net
neutrality, small businesses would be impacted. When asked if they would be concerned by ISPs
discriminating against main street businesses, 79% of all voters were concerned. When asked if
they "agree that small businesses like hardware stores and restaurants should have their websites
run slower than bigger national chains that can afford to pay more for paid prioritization, or a fast
lane," 72% of all voters disagreed. Consumers want to be able to access the content, services,
and applications of their choice online without ISPs controlling their choices.

Once an end-user has chosen an ISP to connect to the internet, there is no alternative pathway for content and application providers to send requested traffic to that user. If paid prioritization is allowed, ISPs will be able to leverage their control over their networks and access to subscribers to allow some websites to be put in front of others at times of congestion. Paid prioritization, moreover, only has value if there is congestion. If capacity is abundant, prioritization has no value. If allowed to monetize congestion, ISPs will not be incented to upgrade their networks and invest in more bandwidth, and with the limited residential competition for ISP service—American consumers will be worse off.[1]

Unfortunately, there has been a conflation of paid prioritization, which encourages network congestion in order to monetize it, with reasonable network management, specialized services, and storage services, like Content Delivery Networks. Reasonable network management can involve unique routing of classes of traffic (but never particular services within a class) to improve the user experience. By definition, reasonable network management has technical, not commercial, motivations. Specialized services are not internet access services at all, but rather purpose-built applications of IP technology that are provided over ISP networks, such as IP television service, or dedicated telemedicine connections, that are outside the scope of net neutrality. Finally, CDNs minimize congestion so networks operate more efficiently for everyone. CDNs are not prioritization. They do not flag certain bits to move before or instead of others. Content delivery networks provide local storage for content closer to the end-user, so that there is less traffic flowing over backbone networks, allowing data to flow at its maximum capability. Content from CDNs go onto an ISP's network wherever, and at whatever rate, an ISP allows that content to enter its network. The way traffic enters an ISP's network is via ports that an ISP controls, this is the same for all CDNs, ISPs, and transit providers.[2] Moreover, the market for CDN services is incredibly competitive. There are dozens of CDN services competing against one another on price and service, ensuring that even the smallest websites are able to store content on a CDN.

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[1] Unfortunately, the majority of Americans only have one high-speed ISP choice at home, and two-thirds have, at best, a duopoly. However, a number of INCOMPAS members are small, competitive ISPs who are bringing new network options to ISP consumers at home. When our member companies enter, incumbent ISPs respond by investing more, increasing their speeds, and dropping their prices. *See* INCOMPAS Reply Comments, Dr. David Evans Analysis, at 35-37, *available at* http://www.incompas.org/files/INCOMPAS%20RIF%20Reply%20Comments-30Aug%20FINAL.pdf.

[2] Some have suggested that edge providers can gain an advantage via the volume of traffic and use of CDNs for better interconnection arrangements by pressuring network operators, presumably ISPs, to upgrade specific nodes. This is preposterous. ISPs control access to their own customers, as well the ability to reach the customers who are requesting the content. Edge providers and CDNs have an incentive to send the content requested via the network paths that allows for the customer to obtain it as their business models are dependent on serving traffic. As INCOMPAS has previously described, however, ISPs have used their market power and leverage to require edge providers to pay tolls in order to avoid blocking and throttling at interconnection. *See* INCOMPAS Letter, WC Docket No. 17-108 (Nov. 20, 2017) (*citing* the New York Attorney General among others who have found that large ISPs were deliberately not upgrading their interconnection infrastructure in order to extract payment—despite the fact that it affected the quality of service for consumers), *available at* http://www.incompas.org/files/FINAL%20INCOMPAS%20Interconnection%20Ex%20Parte%2011_20_2017%201.pdf.

The conflation of these distinct policies and features seems intended to disguise the key issue at stake: Allowing for paid prioritization online would tip the scales in favor of the largest companies with the deepest pockets, while punishing small businesses, non-profits, schools, churches, and entrepreneurs who are seeking to connect their new ideas, products, and services with the world—merely to award large ISPs with the control and ability to impose new tolls online. This would divide the internet into haves and have-nots and allow ISPs to profit off their ability to create and leverage congestion on their networks, resulting in ISPs picking the online winners and losers—rather than American consumers choosing which services and applications are the best. This is not consistent with the public interest and should continue to be banned.

There may be some cases where certain services require a guaranteed quality of service to preserve health or safety. For example, telemedicine or enabling autonomous driving only works if there is sufficient bandwidth and latency. In these cases, quality of service can be guaranteed by buying dedicated capacity to provision these services. The clear distinction between a specialized service and broadband internet access is that specialized services do not require connectivity to the broader internet. Put another way, two hospitals connected to each other in order to perform telesurgery will not need to check their email or watch a movie using that dedicated connection. Both the 2015 and 2010 rules have provided for the ability to sell and operate specialized services.[3]

As INCOMPAS has previously stated, we stand ready to assist the Congress in reinstating the FCC's 2015 open internet policy which ensures that all Americans benefit from using the online content, services, and applications of their choice.
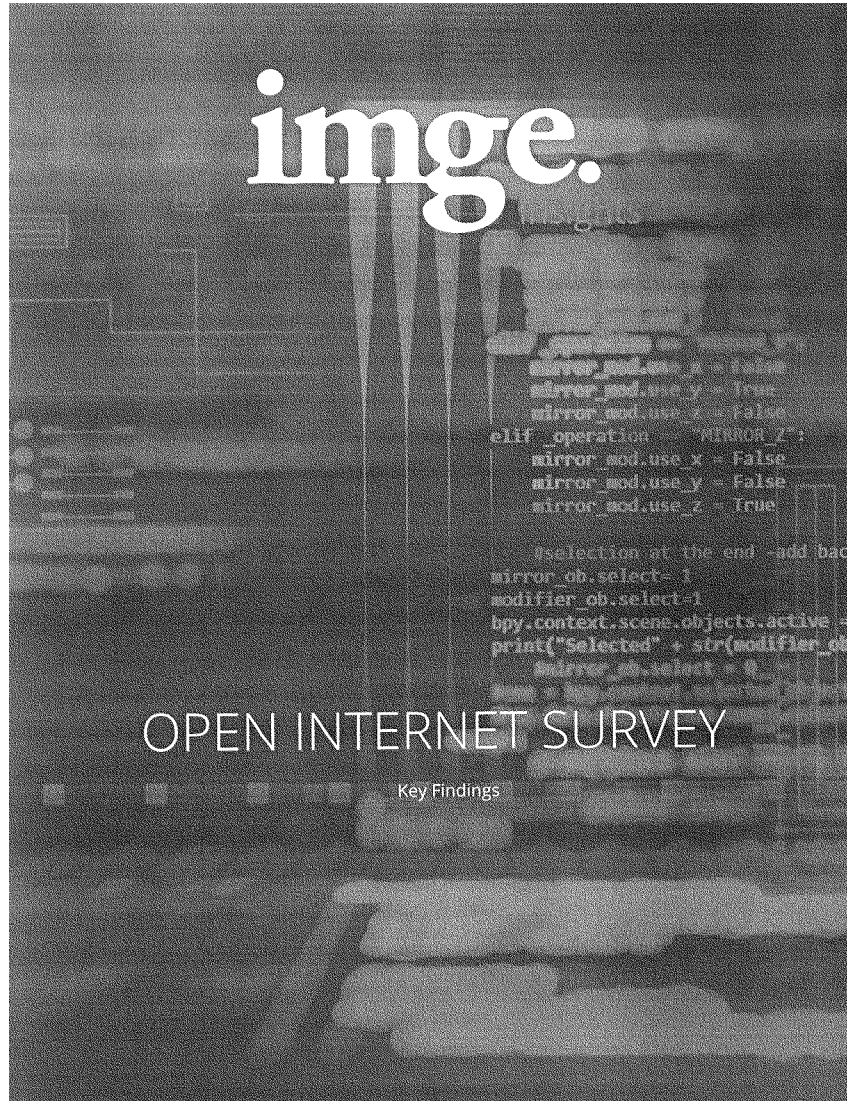
Sincerely,

/s/Angie Kronenberg

Angie Kronenberg
Chief Advocate & General Counsel

Attachment

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[3] Nonetheless, INCOMPAS agrees with the open internet policy that ISPs' internet access service should not be impeded, disrupted, or replaced by these services.

Methodology
IMGE, a Republican consulting firm based in Alexandria, Virginia, conducted a national survey of 1,502 registered voters between June 26-29, 2017 using a mix of online and landline telephone interviews. The margin of error is 2.5%.

Majority support net neutrality
"Do you support or oppose net neutrality?"

	All voters	Republicans	Trump voters
Support	50%	51%	48%
Oppose	16	15	17

Broad consensus the internet has improved under net neutrality

"Overall, do you think the internet has improved over the last few years?"

	All voters	Republicans	Trump voters
Yes	70%	71%	70%
No	20	21	21

Overwhelming support for net neutrality rules

"Companies like Comcast, AT&T, Charter/Time Warner Cable, and Verizon provide home internet access. Today those internet service providers are prohibited from slowing or blocking websites or video services like Netflix. Do you agree that it is necessary for internet service providers to continue to follow these rules?"

	All voters	Republicans	Trump voters
Agree	75%	72%	75%
Disagree	14	15	15

Voters like the internet the way it is under net neutrality
"Do you want the internet to be the internet or do you want the internet to be more like cable?"

	All voters	Republicans	Trump voters
Be the internet	79%	76%	78%
More like cable	9	10	9

Agreement that internet service is a utility and should be regulated like one under net neutrality
"Now I'm going to ask you about a series of statements that have been made in the debate over net neutrality. After each statement, please tell me if you strongly agree, somewhat agree, somewhat disagree, strongly disagree or have no opinion..."

"Internet service is a necessity like water or power at your home."

	All voters	Republicans	Trump voters
Total Agree	71%	72%	69%
Total Disagree	23	24	25

"Internet should be treated like any other utility such as gas or electric service."

	All voters	Republicans	Trump voters
Total Agree	53%	58%	58%
Total Disagree	30	28	28

Near universal consensus in favor of principles of net neutrality
"People should be able to access any websites they want on the internet, without any blocking, slowing down, or throttling by their internet service provider."

	All voters	Republicans	Trump voters
Total Agree	87%	90%	88%
Total Disagree	6	6	7

"Internet service providers should treat all websites and content equally."

	All voters	Republicans	Trump voters
Total Agree	86%	86%	86%
Total Disagree	7	9	9

Voters reject changes to net neutrality that could empower the liberal media
"Companies that own cable news networks like CNN and MSNBC should be allowed to control your access to conservative websites."

	All voters	Republicans	Trump voters
Total Agree	12%	12%	14%
Total Disagree	79	83	82

Republicans agree with President Trump's position to block AT&T – Time Warner merger, break up Comcast
"President Trump said during the campaign that he would block the AT&T – Time Warner merger. Do you agree or disagree with the President's position?"

	All voters	Republicans	Trump voters
Agree	42%	57%	60%
Disagree	33	20	18

"President Trump also said that we should 'break up Comcast'. Do you agree or disagree with the President's position?"

	All voters	Republicans	Trump voters
Agree	33%	47%	50%
Disagree	41	26	22

Voters concerned about how changes to net neutrality will impact small business

"More main street businesses are relying upon the internet to sell their services and goods. They typically have their own websites and use social media to advertise and boost their sales. How concerned would you be if companies like Comcast, AT&T and Verizon could discriminate against main street businesses on the internet?"

	All voters	Republicans	Trump voters
Total Concerned	79%	79%	80%
Total Not Concerned	15	16	15

"Do you agree that small businesses like local hardware stores and restaurants should have their websites run slower than bigger national chains that can afford to pay more for paid prioritization, or a fast lane?"

	All voters	Republicans	Trump voters
Total Agree	19%	24%	27%
Total Disagree	72	67	66

Voters strongly disapprove of ISP's selling private data, browser history to advertisers

"Recently Congress voted to allow internet service providers like Comcast and AT&T to sell your private data and browser history to advertisers and other companies. Do you approve or disapprove of this action?"

	All voters	Republicans	Trump voters
Total Approve	12%	15%	17%
Total Disapprove	83	81	80

"Cable companies are looking to find new revenue sources. Would you support or oppose their selling your personal data and browser history to advertisers - which would allow cable companies to charge websites like Netflix and Twitter more for access to their networks?"

	All voters	Republicans	Trump voters
Total Support	10%	12%	15%
Total Oppose	86	83	82

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April 16, 2018

The American Academy of Pediatrics (AAP) appreciates the opportunity to provide comment related to paid prioritization of internet access. The AAP is committed to the optimal physical, mental, and social health and well-being of all infants, children, adolescents, and young adults. It is the AAP's position that an Open Internet is a vital component in assuring access to health care for children and their families. As such, AAP is opposed to the implementation of paid prioritization because of its detrimental effects on the elimination of health disparities, efficiency of health care, patient safety, and access to health information by patients, parents, and caregivers.

Impact on Health Disparities
Health disparities have been noted for centuries among populations based on socio-economic class and environmental exposure. Children and adolescents are one of the priority populations where health disparities have been documented. Eliminating health disparities is one of the four overarching goals of Healthy People 2020 and one of the four foundational health measure that will serve as an indicator of progress towards achieving the goals.

In fact, Healthy People 2020 defines health equity as the "attainment of the highest level of health for all people. Achieving health equity requires valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices, and the elimination of health and health care disparities." Paid prioritization is not compatible with "addressing avoidable inequalities" and "elimination of health and health care disparities," and, as such, the Academy would not support its implementation. An Open Internet is essential to decreasing health disparities among children and adolescents in the United States.

Further, the Open Internet is necessary to many aspects of health information technology (HIT), including electronic health records (EHRs), consumer e-health tools, telemedicine, population health information systems, health data registries, and health information exchanges. In their briefing paper, *Understanding the Impact of Health IT in Underserved Communities and Those with Health Disparities*, the National Opinion Research Center discussed the impact of HIT on current disparities in health care with regard to quality of care, access to care, health outcomes, patient engagement, and chronic disease management. The authors concluded that patient and provider access to the internet is key to decreasing health disparities in these areas and improving quality of care for children.

Impact on Efficiency of Care and Patient Safety
An Open Internet is important to maximizing efficiency for health care organizations and clinicians who may use web-based systems for billing, making referrals, and managing other aspects of patient care. If organizations and

clinicians do not have the financial ability to obtain "priority" Internet access, they will be limited in their ability to provide the high quality, patient-centered, cost effective care recommended as part of the ongoing transformation and reform of our nation's health care system.

With the increasing use of cloud-based HIT, clinical decision support and health information exchange, slower response times will have an impact on the safety of children and adults. For example, if a patient is in an emergency room and their records at another location can save their life, an Open Internet is absolutely essential so that appropriate care can be delivered as quickly as possible. There are many other circumstances where an Open Internet can support patient safety efforts and where "paid prioritization" will decrease the safety of clinical care.

Impact on Access to Health Information
Currently, 94% of pediatricians are using EHRs. Increasingly, the EHRs store patient data in the cloud, where it has to be retrieved for episodes of care. Pediatricians also remain among the lowest paid group of physicians in the United State. Paid prioritization of Internet access to stored EHR data could result in delayed or interrupted care and could become quite costly to pediatricians, thus increasing the cost of caring for children.

In addition, the general public, including parents and caregivers of children, uses web-based platforms to access children's medical records, make appointments, and find health information. Having slower access to these tools could potentially result in delays in care and seeking information and place an undue burden on ready access to quality health care and health information. Access to educational resources online, to which pediatricians routinely refer patients and their parents, would also become more difficult to access and would hamper efforts of engaging patients in their care.

Finally, the 21st Century Cures Act specifically contained language that discouraged information blocking and gave the Office of the Inspector General at the Department of Health and Human Services the authority to investigate claims of information blocking and assign penalties for practices found to be interfering with the lawful information sharing between EHRs. Paid prioritization could essentially allow information blocking as organizations and clinicians are unable to quickly and efficiently provide access to patient information between EHRs.

For all of the reasons outlined above, the AAP believes that establishing a system of "paid prioritization" is contrary to the health and well-being of infants, children, adolescents, and young adults. An Open Internet is essential to decreasing health disparities among children and adolescents, improving efficiency of health care, assuring patient safety, and improving access to health information by patients, parents, and caregivers.

The AAP appreciates the opportunity to provide comments on the Open Internet. If the Academy can be of any further assistance, please contact Patrick Johnson in our Washington, D.C. office at 202/347-8600, or pjohnson@aap.org.

Sincerely,

Colleen A. Kraft, MD, FAAP
President

CAK/pmj

NATIONAL ASSOCIATION *of* **REALTORS®**

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2018 President

Bob Goldberg
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April 16, 2018

The Honorable Marsha Blackburn
Chair
House Communications & Technology
Subcommittee
2266 Rayburn House Office Building
Washington, DC 20515

The Honorable Mike Doyle
Ranking Member
House Communications & Technology
Subcommittee
239 Cannon House Office Building
Washington, DC 20515

Re: NAR Opposes Paid Prioritization

Dear Chair Blackburn and Ranking Member Doyle:

On behalf of the 1.3 million members of the National Association of REALTORS® (NAR), I would like to express NAR's belief that open internet rules are necessary to support a wide range of common real estate business practices. These business practices rely on the Internet, which has improved the ability of real estate professionals to offer homebuyers and businesses the tools to make efficient, better-informed decisions when looking for a new home or commercial site. Chief among these critically important rules is a prohibition on paid prioritization.

The Internet has been a driving force for innovation for decades, and our members, their customers, and local communities are benefiting from this innovation every day. The economic growth and job creation fueled by the open Internet is unprecedented in American economic history. This growth has been fostered by the FCC under both Republican and Democratic administrations for over a decade.

Our members, who identify themselves as REALTORS®, represent a wide variety of real estate industry professionals. REALTORS® have been early adopters of technology, and are industry innovators who understand that consumers today are seeking real estate information and services that are fast, convenient and comprehensive. Increasingly, technology innovations are driving the delivery of real estate services and the future of the real estate sales businesses. Real estate firms vary widely in size, but the overwhelming majority is composed of very small entities. NAR's most recent surveys indicate that more than half of all realty firms have less than twenty-five agents, and the typical sales agent is affiliated with an independent realty firm with a single office.

Streaming video, Voice over Internet Protocol, cloud storage and mobile applications are commonly used in our businesses today. Without protections from the Open Internet Order, consumers may experience slow or degraded delivery of home search videos creating barriers in the very first step in the home buying process. In the future, new technologies, like virtual reality and telepresence among others, will be available that will no doubt require open internet access unencumbered by technical or financial discrimination.

Paid prioritization of internet content would be especially harmful to our small business members. Small companies will be at a serious disadvantage as larger firms use paid prioritization for anti-competitive reasons. Since studies show that even small changes in web page loading times can have significant impacts on user behavior, a company that

can pay to connect to their users faster will be at a huge advantage. Paid prioritization imposes artificial and arbitrary limits on the speed of some traffic in order to prioritize traffic that has paid a toll. It is inefficient and unnecessary from a traffic management standpoint, and the only rationale for imposing paid prioritization is to shake down businesses on the internet that consumers are already paying ISPs to access.

Unfortunately, H.R. 4682, The Open Internet Preservation Act allows ISPs to engage in paid prioritization by making clear the FCC should have no authority over Broadband Internet Access Service (BIAS) other than to prevent the blocking or degradation of lawful internet traffic. As a result, we have serious concerns with this bill.

The benefits of broadband Internet for innovation and economic development are unparalleled. However, the nation will lose those tremendous benefits if the Internet does not remain an open platform, where Americans can innovate without permission and with low barriers to launching small businesses and creating jobs. Given this reality, it is important that Congress enact strong net neutrality protections including a ban on paid prioritization. We look forward to working with you on this important issue.

Sincerely,

Elizabeth Mendenhall
2018 President, National Association of REALTORS®

cc: House Committee on Energy and Commerce

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Center for Connected Health Policy
The National Telehealth Policy Resource Center

*The Center for Connected Health Policy is the **Federally Designated** National Telehealth Policy Resource Center*

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April 16, 2018

The Honorable Marsha Blackburn
Chair, Subcommittee on Communications and Technology
House Committee on Energy & Commerce
2266 Rayburn Building
Washington, Dc 20515

The Honorable Michael Doyle
Ranking Member, Subcommittee on Communications and Technology
House Committee on Energy & Commerce
239 Cannon HOB
Washington, DC 20515

RE: Comments for the record on Internet Prioritization

Dear Chairwoman Blackburn and Representative Doyle:

On behalf of the Center for Connected Health Policy (CCHP), I am submitting the following comments regarding the rollback on net neutrality and discussion of paid prioritization. CCHP is the federally designated national telehealth policy resource center. CCHP provides non-partisan research, information and technical assistance on issues related to telehealth policy to both state and federal policymakers. It has been serving the nation and telehealth community in this role since 2012. CCHP is a program under the Public Health Institute, an independent non-profit dedicated to improving health and wellness by discovering new research, strengthening key partnerships and programs, and advancing sound health policies.

The rollback of net neutrality raises several concerns on the potential impact such action could have on the use of telehealth, particularly for rural and underserved communities, and impeding recent policies and goals of the Administration, Congress and states in addressing various health issues. Telehealth is the use of technology to provide health services where the patient and provider are not in the same location. In the past few years, telehealth has generated increasing interest in how it could meet health needs and address public health concerns, most recently how it could be used to address the current opioid epidemic. Telehealth, however, cannot exist without a reliable, robust connection. Both providers and patients will not utilize the technology if the connection is unreliable or uneven. Additionally, dropped connections or pixilated images during an actual consultation could have significant consequences depending on the delicacy of the interaction, for example,

CCHP is a program of the Public Health Institute

during a mental health consultation. Therefore, the limitation of access to connectivity is a significant barrier to the use of telehealth.

Impact on Community Health Centers

Community Health Centers (CHCs) serve over 27 million people in every state. CHCs save the US health care system $24 billion through reduction of unnecessary hospitalizations and emergency room visits.[i] CHCs have also found themselves to be at the forefront of addressing the opioid epidemic having received federal funding such as the September 2017 Health Resources and Services Administration (HRSA) grants of $200 million to 1,178 health centers and rural health organizations in every state to increase mental health and substance use services. A part of that funding was specifically used for the Substance Abuse Treatment Telehealth Network Grant Program (SAT-TNGP). Transmission and clinician payment is capped under this program at $90 per session/encounter.[ii] Any change to the rates for connectivity will impact these programs.

Beyond recent targeted funding for programs, CHCs have explored or established telehealth programs to meet the needs of their communities. In 2016, 57% of the CHCs in the nation were in the process or began implementing a telehealth program.[iii] According to the National Association of Community Health Centers (NACHC):

> Of these, 523 health centers, or 38% of all health centers, used telehealth to deliver needed services or help patients monitor their chronic conditions in 2016. Telehealth programs were especially popular in rural health centers, where many residents can face long distances between home and health provider, particularly specialized providers. In rural communities, nearly half (46%) of health centers utilized telehealth technologies, compared to one-third (32%) of urban health centers.[iv]

Recent draft legislation in both houses had looked to CHCs as providing services via telehealth to combat the opioid epidemic. If these centers cannot afford the connection, they will not be able to establish such programs. While FY 2018 Omnibus Appropriations bill did provide an additional $300 million to CHCs, that amount is potentially inadequate to sustain a telehealth program that may see significant increases in costs to maintain connectivity.

Paid Prioritization May Not Work for CHCs

Paid prioritization has been offered as a potential solution to avoid impacts on telehealth. However, many CHCs operate on slim margins and unlike larger hospitals and health systems, may not have the extra funding to pay for the robust connectivity needed in a telehealth interaction. For example, according to a NACHC 2015 survey, 79% of health centers reported plans to initiate capital projects, but 75% of those centers reported funding gaps for those projects.[v] The loss of these telehealth programs could then disproportionately impact certain groups more given the populations CHCs serve, such as rural and low income communities.

Potentially, some policy could be crafted protecting and exempting CHCs from possible rates that would price them out of using telehealth. However, while policy to protect could be crafted for established health entities like CHCs, the individual consumer that directly utilizes the unique features of telehealth could be dramatically impacted by the rollback of net neutrality and there could be further impediment to the growth of telehealth.

Potential Disproportionate Impact on Individual Use of Telehealth in the Home

One of the unique features of telehealth is the ability to use it to provide care anywhere, including in non-traditional health care settings such as the home or schools. Some of the most compelling published research

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around telehealth that highlights the impact on positive health outcomes as well as cost savings is related to a modality of telehealth known as remote patient monitoring (RPM). This modality is the continuous monitoring of patients by a provider from a distance. A lot of the published research examines the use of RPM within the patient's home.

With the elimination of net neutrality and the possibility of paid prioritization, the individual will be asked to pay more to ensure they have that a robust connection to access these health services. While policy could be crafted to protect health centers or institutions, it would be much more difficult to ensure the individual has that comparable protection if they are using their home connection for health purposes. Potential policies would have to include subsidies to the individual which raises costs somewhere else and/or monitoring of use which raises questions of privacy.

If the use of the telehealth in the individual's home is impeded, it runs counter to current efforts and policies put forward by both the Administration and Congress. These current efforts include:

- Center for Medicaid and Medicare Services (CMS) – Since 2015, CMS has been promoting the use of Chronic Care Management (CCM) services that allow services to be provided in the home.
- S 925/HR 2123 –The VETs Act of 2017 – Would allow a covered health professional to provide services via telehealth (telemedicine is the term used in the bill) within the Veterans Administration (VA) system regardless of the location of the health professional or patient.
- Similar language to S 925/HR 2132 is in the proposed rule by the VA allowing telehealth delivered services to be provided regardless of the location of the patient and provider.
- Bipartisan Budget Act of 2018 – Includes the home as an eligible originating site for Accountable Care Organizations (ACOs) and for patients receiving End Stage Renal Disease (ESRD) home dialysis to also receive monthly ESRD-services in the home via telehealth.

Each of these policies could be hamstrung should individuals find it difficult to purchase adequate connectivity to utilize these services, which have shown to be effective, produce beneficial health outcomes and save money.

Impact on State Policies

In the years CCHP has served as the federally designated national telehealth policy resource center, we have tracked an increased interest and adoption of telehealth policies within state governments. As of October 2017, nearly all states have some type of reimbursement for telehealth within their Medicaid programs:

- 48 States & DC reimburse for live video services
- 15 States reimburse for store-and-forward (a modality that does not take place in real time such as capture of some type of information that is sent to a physician to be reviewed later. For example a photo of a skin condition that is sent to a dermatologist).
- 21 States reimburse for RPM[vi]

The limitation of access to connectivity could also greatly impact the efforts states have made in telehealth policy. In the 2017-2018 legislative session, 167 state bills related to telehealth have been introduced in 37 states. The loss of available connectivity could stall the progress and efforts on the state level as well.

CCHP urges careful consideration of policies related to net neutrality to avoid any unintended impacts on the utilization of telehealth and the people who can benefit from it, especially those that run counter to policies proffered and supported by the Administration and Congress. Please feel free to contact CCHP for further information or clarification of these comments. Thank you for your time and consideration of these comments.

Respectfully,

Mei Wa Kwong, JD
Executive Director

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[i] National Association of Community Health Centers, "Building Upon A Successful Model", < http://www.nachc.org/wp-content/uploads/2018/03/NACHC-2018-Policy-Paper-Funding.pdf>. (Accessed April 16, 2018).
[ii] Health Resources & Services Administration, Substance Abuse Treatment Telehealth Network Grant Program, Funding Opportunity HRSA-17-22, p. 15.
[iii] National Association of Community Health Centers, "The Health Center Program is Increasing Access to Care through Telehealth, February 2018" < http://www.nachc.org/wp-content/uploads/2018/02/Telehealth_Snapshot_FINAL_2.22.18.pdf>. (Accessed April 16, 2018).
[iv] Ibid.
[v] National Association of Community Health Centers, "Community Health Center Chartbook, June 2017", < http://www.nachc.org/wp-content/uploads/2017/06/Chartbook2017.pdf>. (Accessed April 16, 2018).
[vi] Please note that there are various limitations in each of these categories such as reimbursement to only certain providers, services, etc. Policies vary drastically from state to state.

AEI

Roslyn Layton

@RoslynLayton

April 17, 2018 6:00 am | *AEIdeas*

Prioritization: Moving past prejudice to make internet policy based on fact

Technology and Innovation, Telecommunications

The internet has evolved from its original design as a backbone-oriented, end-to-end infrastructure for academics to a series of content delivery networks (CDNs) that deliver video entertainment for end users. About 80 percent of today's internet's traffic is driven by the business models of Google, Amazon, and Netflix, companies that are both networks and applications undergirded by massive data centers and private networks. While their success underscores their business prowess and compelling content, today's de facto result is not what the internet's architects had in mind. Had they anticipated that video would be the main use, they would have selected a different network design.

Via Twenty20

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The Federal Communications Commission's (FCC) 2015 Open Internet Order made a blanket ban on something it called "paid prioritization," or "the management of a broadband provider's network to directly or indirectly favor some traffic over other traffic." The implication is that internet service providers (ISPs) can "speed up" traffic, but this is not possible because packets cannot be retransmitted by a network any faster than it receives them. The FCC failed to cite real-world examples of the practice or evidence proving its harm. Within network engineering, prioritization refers to scheduling and queuing technologies, which could be envisioned as a bike path and a walking path. If some traffic uses the bike path, it does not disadvantage the walking path traffic. However, the question remains whether the FCC banning the bike path altogether disadvantaged some services, as Voice over Internet Protocol (VOIP) co-founder Dan Berninger notes in his petition at the Supreme Court. While CDNs perform a service that amounts to paid prioritization, hosting content close to users to shorten the distance it travels for a fee, leading CDN provider Akamai succeeded in its effort to carve out its services from regulation, as the order's footnotes attest.

Today's House Energy and Commerce Committee hearing, led by Rep. Marsha Blackburn (R-TN), is a step toward addressing the wrongs of the Open Internet Order by removing its incentives for arbitrage and ensuring that specific measures regulating network capabilities (e.g., prioritization) are based in science and engineering. Here are some key points paraphrased from the submitted testimony of today's witnesses.

Richard Bennett:

While 80 percent of the bandwidth is consumed by a few giant players (which essentially don't contribute to the cost of last mile networks), a diverse pool of users and applications compete for access to critical network resources such as bandwidth, latency, packet loss, and jitter. New networking product lines such as WAN edge infrastructure, software defined networking, and managed services overcome shortcomings in the internet's design by enabling dynamic routing or path selection. These devices enable the internet to replace costly private lines for many enterprise applications. ISPs can do the best job of traffic optimization when they can identify the nature and requirements of individual packet streams. The most effective way to do this — while preserving privacy — is to allow application developers to register applications requiring special treatment and even to pay for such treatment in some circumstances. While the average speed of US broadband networks has increased 35 percent per year for a decade, web performance has remained stagnant, even decreasing in 2016. The interests of innovators are best served when they are able to purchase the network services they need without undertaking the breathtaking expense of building the networks of data centers owned by the five largest US firms.

Peter Rysavy:

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5G, the next and fifth generation mobile wireless standard, is new network typology and architecture designed to handle different kinds of traffic flows and a wider range of use cases than 3G and 4G. These include autonomous vehicles with crash sensing and mitigation, health biometric sensing and response, telemedicine, and proactive monitoring of critical physical infrastructure such as transmission lines. These applications require minimal delay and high reliability, and this can't be guaranteed without prioritization. Importantly, prioritization increases the quality of experience across the subscriber base — however, bright-line rules against prioritization will deter service development and investment incentives, threatening and undermining America's leadership in 5G.

Paul W. Schroeder, Aira Tech Corp:

Aira helps the visually impaired enjoy a level playing field with those who can see by leveraging the capabilities of emerging 5G networks. It offers its blind customers instant, next generation wireless access to visual information through smart glasses, augmented reality, machine learning, geolocation, sensors, and trained human agents. Aira won't work with best efforts as it requires a robust network with dependable connectivity. Aira employs AT&T's Dynamic Traffic Management solution to ensure users low latency and robust connectivity for the transmission of streaming video. Aira's customers or "explorers" use it to navigate city streets and airports, review printed material, catch public transportation, and get real-time assistance for job applications, shopping, and travel.

Claims against prioritization and the counterarguments

Witness and Free Press Policy Director Matt Wood's testimony was not available at the time of writing, but advocates against prioritization counter that the 2015 order had carve outs for telemedicine, suggesting that it preserved the "good" uses cases for prioritization. But it's not logical that only telemedicine should be able to enjoy unrestrained innovation while other apps for transportation, supply chain, public safety, and so on would be denied. Such technologies, whether purchased by consumers or companies, can ensure users, for example, a quality video signal during an online job interview when the network is congested or the prioritization of public safety signals during emergencies.

A second claim is that innovative services will never be delivered on the public internet because developers will opt for private networks. Such an option is prohibitively expensive, would increase the cost for end users, and deter innovative service adoption. Moreover, it's inefficient to build separate networks when the public internet can offer these services the capabilities they need.

The use of prioritization will no more slow the internet than the use of FedEx slows the mail. Indeed Amazon avails its Amazon Prime customers to priority delivery via the United States Postal Service.

None of America's key competitors in 5G — Japan, South Korea, or China — have adopted bans on paid prioritization. They would not be so stupid to handicap their citizens and innovators with rules that constrain an advanced network's capability.

The US now faces a global competition for 5G leadership and can't afford to be captured by emotional calls to imaginary harms. The committee is taking forthright, evidence-based leadership in making policy and investigating the facts before making up rules. It's a standard that all regulatory agencies should adopt.

Learn more: Paid prioritization: Debunking the myth of fast and slow lanes (http://www.aei.org/publication/paid-prioritization-debunking-the-myth-of-fast-and-slow-lanes/) | States join the net neutrality #resistance: Will it make a difference? (http://www.aei.org/publication/states-join-the-net-neutrality-resistance-will-it-make-a-difference/)

Federal Communications Commission (FCC), Net neutrality, Regulation, Telecommunications

ΛΜΙΛ

INFORMATICS PROFESSIONALS. LEADING THE WAY.

April 16, 2018

Honorable Marsha Blackburn
Chairman
Energy & Commerce Committee
Subcommittee on Communications and
Technology
2125 Rayburn House Office Building
Washington, D.C. 20515

Honorable Michael Doyle
Ranking Member
Energy & Commerce Committee
Subcommittee on Communications and
Technology
2125 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Blackburn and Ranking Member Doyle:

The American Medical Informatics Association (AMIA) applauds the House Energy & Commerce Committee's continued exploration into the challenges and opportunities presented by our ever-expanding Internet-based economy and application ecosystem. The topic of your hearing, "From Core to Edge: Perspective on Internet Prioritization," is a central consideration in the ongoing debate over the role of government in balancing support for consumer protections with support for innovation.

AMIA is the professional home for more than 5,500 informatics professionals, representing front-line clinicians, researchers, educators and public health experts who bring meaning to data, manage information and generate new knowledge across the health and health care enterprise. As the voice of the nation's biomedical and health informatics professionals, AMIA plays a leading role in advancing health and wellness by moving basic research findings from bench to bedside, and evaluating interventions, innovations and public policy across settings and patient populations.

As a membership-driven organization dedicated to the science of data collection, analysis, and application, AMIA strives to deliver evidence-based policy recommendations that focus on the opportunities and challenges of implementing health informatics tools, such as electronic health records (EHR), health information exchanges, clinical decision support, and other kinds of analytics tools to support health, care, and research.

AMIA posits that (1) access to high-speed broadband greatly determines the trajectory of individuals' health; (2) increasingly, care is delivered outside the four walls of our traditional healthcare system and more data are being exchanged across geographic and organizational boundaries to support such care; and (3) individuals are being empowered and incentivized to leverage consumer technologies to prevent and manage disease through Internet-connected devices. **Together, these factors presage a need to ensure a robust health broadband economy driven by public policy that encourages low-cost broadband options with open access and transparent terms of service.** This is especially needed for medically underserved Americans, who are more likely to reside in poor and rural areas of the country where existing broadband options are inferior.

<u>Broadband as a Social Determinant of Health</u>

While it is difficult to know definitively how paid prioritization might impact connectivity, latency, and speed at a systems level, the removal a basic consumer protection coupled with a loss of oversight authority makes for dubious circumstances. What we do know is that lack of access to broadband Internet services in the home or community negatively impacts individuals' health, and the problem is magnified for racial and ethnic minorities, persons of lower socioeconomic status, and other disadvantaged groups.[1,2,3] It is, therefore, possible to conclude that diminished access to broadband – and the applications that comprise the emerging broadband health ecosystem – will have similarly negative effects.

In our view, the role of public policy should be one that encourages low-cost broadband options through increased competition with open access (i.e. no additional cost to connect to specific kinds of applications and content) and transparent terms of service (i.e. clearly stated performance expectations). Arguably, paid prioritization runs counter to the goal of open access. While we acknowledge that there could be definable instances where prioritization could be useful, such as for telehealth services, we also question the need for paid prioritization given the existence of exemption options for non-Broadband Internet Access Services, also referred to as non-BIAS data services.[4]

As a practical matter, the oversight of a system that does not allow for paid prioritization, except for under clearly articulated and thoroughly considered conditions, would be easier to manage than a system that allows for such prioritization unless or until there is inappropriate behavior. The number and types of regulatory controls that would need to be in place to understand and substantiate claims of inappropriate behavior would negate any perceived gains in removing the prohibition on paid prioritization. **AMIA recommends a thoughtful examination of exemptions, rather than wholesale removal of the prohibition, as a reasonable and responsible next step.** Congress could review the number and nature of exemption applications, as well as consider the impact of the exemptions once granted. Fundamentally altering the existing "best efforts" basis upon which Internet traffic is delivered should not be a step taken lightly.

<u>Distributed and Virtual Care Delivery</u>

[1] Perzynski A., Roach, M.J., Shick, S. et al; Patient portals and broadband internet inequality. J Am Med Inform Assoc 2017 ocx020. doi: 10.1093/jamia/ocx020
[2] Graetz I, Gordon N, Fung V, et al. The Digital Divide and Patient Portals: Internet Access Explained Differences in Patient Portal Use for Secure Messaging by Age, Race, and Income. Med Care. 2016 Aug;54(8):772-9. doi: 10.1097/MLR.0000000000000560.
[3] Gibbons, M.C., Wilson, R.F., Samal, L. et al. Consumer health informatics: results of a systematic evidence review and evidence based recommendations. Behav. Med. Pract. Policy Res. (2011) 1: 72. doi:10.1007/s13142-011-0016-4
[4] FCC Order 15-24 states on pg. 58 "[W]e note that telemedicine services might alternatively be structured as 'non-BIAS data services,' which are beyond the reach of the open Internet rules.", *available at*: https://transition.fcc.gov/Daily_Releases/Daily_Business/2015/db0312/FCC-15-24A1.pdf.

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While speculative, there are numerous scenarios involving the use of Internet-reliant health informatics tools that could be impacted negatively by a tiered servicing scheme that results in fewer service options or increased costs. These tools are both institution-focused as well as – and increasingly – individual-focused.

Healthcare delivery has undergone a digital transformation in the last five years. More than 96 percent of U.S. hospitals[5] and 83 percent of U.S. office-based physicians[6] have adopted EHR systems. Some of these EHR systems are cloud-based, requiring fast, reliable Internet to access stored data. There is also a fledgling effort by the federal government to establish a network-of-networks for all EHRs to exchange health data, known as the Trusted Exchange Framework and Common Agreement, or TEFCA.[7] Under this policy, a physician in Oregon can access a vast network of patient records beyond her own EHR by connecting to a local hub. The government hopes that the same network can deliver bulk access to many patient records at one time for quality and cost assessments.[8]

Other Internet-reliant tools include telehealth and telemedicine, many of which utilize high-resolution images, video, and voice conferencing. Various healthcare organizations are experimenting with remote patient monitoring, fitness trackers, and mobile health applications that rely on Internet connections to better develop pictures of their patients' health, as well.[9]

While some institutions may have the resources to easily handle increased prices for prioritization, many others will not. And given that individuals increasingly rely on Internet-based consumer electronics to manage and prevent disease, the unknown variables of paid prioritization beg caution. Numerous hospitals that would benefit from telehealth and remote patient monitoring service rural areas, which are already at a disadvantage when it comes to Internet access.[10] Introducing paid prioritization may be helpful in delivering reliable broadband, but if such services are not affordable, the benefits are lost.

Patient Empowerment

Recent updates to Apple's iPhone and iPad give individuals the ability to view their health records.[11] While this may not seem a momentous feat, it could be the catalyst for a nascent ecosystem of

[5] Henry, J., Pylypchulk, Y., et al. Office of the National Coordinator for Health IT, "Adoption of Electronic Health Record Systems among U.S. Non-Federal Acute Care Hospitals: 2008-2015," Data Brief No. 35, May 2016
[6] Heisey-Grove, D., Vaishali, P. Office of the National Coordinator for Health IT, "Any, Certified, and Basic: Quantifying Physician EHR Adoption through 2014," ONC Data Brief, No. 28, Sept. 2015
[7] Office of the National Coordinator for Health IT. Trusted Exchange Framework and Common Agreement. https://www.healthit.gov/topic/interoperability/trusted-exchange-framework-and-common-agreement
[8] Ibid.
[9] See also "Redefining Our Picture of Health: Towards a Person-Centered Integrated Care, Research, Wellness, and Community Ecosystem:" A White Paper of the 2017 AMIA Policy Invitational. Available at: https://www.amia.org/sites/default/files/API-2017-White-Paper-Redefining-our-Picture-of-Health.pdf
[10] Connect2HealthFCC. Mapping Broadband Health in America 2017. Map available at: https://www.fcc.gov/reports-research/maps/connect2health/#ll=40,-95&z=4&t=broadband&bbm=fixed_access&dmf=none&zlt=county
[11] Farr, C. "Apple will let you keep your medical records on your iPhone," CNBC. January 24, 2018

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INFORMATICS PROFESSIONALS. LEADING THE WAY.

consumer-driven health-related mobile applications. Much like access to, and utilization of, high-quality health care and prevention strategies, mobile Health (mHealth) technologies that rely on broadband services have a wide adoption variance based on geography, population density, and socioeconomic status. Vulnerable groups face specific challenges related to inadequate access to affordable and consistent high-speed Internet. Race, ethnic, and age disparities in patient portal use and readiness and preferences for using digital communication for health-related purposes have shown to be significant,[12] and this, in turn, reduces their ability to participate in many new and exciting mHealth solutions. These groups would benefit from an environment that fosters low-cost broadband options with access that would be open and as ubiquitous as possible.

It is difficult to know how the current exemption system might treat this ecosystem, as patients and individuals are the impetus for such technologies, not hospitals and health systems. Nevertheless, should paid prioritization result in content- or producer-dependent pricing and performance variance, we would expect a widening of the digital divide and a worsening of health disparities.

Conclusions

Given that so much is unknown about the future impact of paid prioritization, AMIA strongly urges caution. Congress would do well to favor legislative options that can substantiate claims of benefit as well as claims of harm. Leveraging the existing pathway of non-BIAS exemption is the responsible way to test such claims. Such an approach allows for measured experimentation, while keeping important oversight mechanisms in place to mitigate growing health disparities among those that can afford to participate in our increasingly digital health system, and those who cannot.

We appreciate this opportunity to submit this statement for the record. Should you have any questions or require additional information, please contact AMIA Vice President for Public Policy Jeffery Smith at jsmith@amia.org or (301) 657-1291 ext. 113. We look forward to further dialogue on this issue.

Sincerely,

Jeffery R. L. Smith, M.P.P
Vice President of Public Policy
AMIA

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[12] Gordon N.P., Hornbrook M.C. Differences in Access to and Preferences for Using Patient Portals and Other eHealth Technologies Based on Race, Ethnicity, and Age: A Database and Survey Study of Seniors in a Large Health Plan. J Med Internet Res. 2016 Mar 4;18(3):e50. doi: 10.2196/jmir.5105.

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ConsumersUnion®

POLICY & ACTION FROM CONSUMER REPORTS

April 17, 2018

The Honorable Marsha Blackburn
Chairman, Subcommittee on Communications and Technology
House Energy and Commerce Committee
2125 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Michael Doyle
Ranking Member, Subcommittee on Communications and Technology
House Energy and Commerce Committee
2322A Rayburn House Office Building
Washington, D.C. 20515

Consumers Union, the advocacy division of Consumer Reports,[1] writes to express our views on the U.S. House Energy & Commerce Committee, Subcommittee on Communications and Technology's hearing, *"From Core to Edge: Perspective on Internet Prioritization"* being held today. The hearing will discuss "paid prioritization" on the internet and its place in the larger net neutrality debate. In a nutshell, should paid prioritization be allowed and is it good or bad for consumers?

In 2015, the Federal Communications Commission (FCC) adopted net neutrality rules banning paid prioritization, where an internet service provider (ISP) like Comcast or Verizon can charge consumers and edge providers more for a dedicated "fast lane" to the internet, including specific websites we visit or apps we use on our smartphones. Paid prioritization would allow those content providers and consumers who can pay more to skip to the front of the line or use a special lane apart from the whole of internet traffic, thus enjoying better access to faster-loading content. But for the rest of us who cannot afford prioritized access, it would make it harder for smaller companies to compete and consumers may be stuck with a slower, congested internet.

Fast forward three years later and the FCC, under new leadership, decided to lift the ban on paid prioritization, along with rules that barred ISPs from blocking or throttling access to websites and apps. The Commission decided it was better to have no rules at all, believing broadband internet access is not a telecommunications service worthy of basic, non-discriminatory common carrier rules. This absence of regulations — not upon the internet but

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[1] Consumer Reports is the world's largest independent product-testing organization. It conducts its policy and mobilization work in the areas of telecommunications reform, as well as financial services reform, food and product safety, health care reform, and other areas. Using its more than 50 labs, auto test center, and survey research center, the nonprofit organization rates thousands of products and services annually. Founded in 1936, Consumer Reports has over 7 million subscribers to its magazine, website, and other publications.

upon service providers like AT&T—leaves ISPs to tinker with new business models bound by few, if any, consumer protections. And, to be very clear, nothing will stop ISPs from blocking internet traffic or erecting toll booths that will have the effect of restricting content and consumer choice.

Consumers Union has been a long-time supporter of net neutrality rules and has opposed paid prioritization for a variety of reasons. Granting ISPs the power to charge tolls for access to both consumers and content on the internet gives those same ISPs control over who wins and loses on the internet. Unlike edge providers like Amazon or YouTube, ISPs possess "last-mile" entry into consumers' homes and devices, and that represents genuine gatekeeper power in the marketplace. With many consumers only having one, or maybe two choices for broadband service, there is little option but to tolerate the fees charged by, and the business practices engaged in, (be it blocking or paid prioritization), by their ISP. And, make no mistake, the *primary* reason that ISPs want to be free to engage in paid prioritization schemes is not to benefit consumers, but to increase their bottom line.

We are sure to hear a slew of arguments in favor of paid prioritization at this hearing, many of them pushed by ISPs for years. Some might even suggest that consumers will actually want the option of paying more for new, prioritized fast connections. It is not clear exactly what these new offerings will look like. And while ISPs promise a better overall online experience with these products, it is very possible that consumers will have to pay more just to maintain the service they have today. We find it difficult to imagine how adding a new cost to access the internet will help improve the consumer experience.

Another claim pushed by the industry is that paid prioritization is necessary for dedicated internet access to service a patient's pacemaker or other telemedicine application. Without it, they argue that these services—which could also include home security monitoring systems or remote energy thermostats—will not be prioritized and get lost in the shuffle with everything else online.

This is simply false.

When the FCC adopted net neutrality rules in 2015, it carefully considered that critical services—like a medical device or autonomous vehicle sending data back and forth over the internet—required dedicated, priority access outside of the consumer or commercial internet that the rest of use on a daily basis to surf online or stream video. That's why the Commission created an exception for these "specialized services," or what is now referred to as "non-BIAS (broadband internet access service) data services." The FCC even saw that this exception could be used to facilitate important, life-saving telemedicine devices and applications. This carve-out designed for critical or emergency services came with one condition: it could not be used as a loophole to avoid the rules that applied to the larger, commercial internet.

The FCC went even further beyond the non-BIAS data service exception and allowed ISPs a more general exception by permitting "reasonable network management" to ensure that some services, (e.g., an emergency alert) could be prioritized over others. To imply that paid

prioritization is needed to ensure that a life-or-death service dependent upon an internet connection ignores the plain text of FCC rules already in place.

Paid prioritization is a practice that not only gives ISPs control over how we access the internet, but would also give them control over the content that we are able to access. It fundamentally changes the nature of the internet as we have come to know it, where content is treated the same by ISPs and everyone competes on a level playing field. If an ISP can persuade lawmakers that for an extra fee, it will make sure that a loved one's heart monitor will prioritized 24/7 over your neighbor's Netflix binge watching, we could all end up paying more for something we are already entitled to under the law.

For these reasons, Consumers Union remains opposed to paid prioritization, and will work to restore the net neutrality protections recently stripped away by the FCC.

Sincerely,

Jonathan Schwantes
Senior Policy Counsel
Consumers Union
1101 17th Street, NW Suite 500
Washington, DC 20036

cc. The Honorable Greg Walden
Chairman, House Energy and Commerce Committee

The Honorable Frank Pallone
Ranking Member, House Energy and Commerce Committee

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Josh Constine ✅ @JoshConstine · Nov 22 ⌄
Some tech billionaire, please buy out the local ISP(s) where FCC chairman
Ajit Pai lives and give him 14.4k dial-up speeds for killing net neutrality

💬 24   🔁 409   ♡ 1.3K   ✉

Matthew Prince ✅
@eastdakota   ⌄

Replying to @JoshConstine
I could do this in a different, but equally effective, way.

7:20 PM · Nov 22, 2017

110 Retweets   **428** Likes

💬   🔁   ♡   ✉

Josh Constine ✅ @JoshConstine · Nov 22 ⌄
Replying to @eastdakota
Please, do go on...

💬 1   🔁 2   ♡ 32   ✉

Matthew Prince ✅ @eastdakota · Nov 22 ⌄
sent note to our GC to see if we can without breaking any laws.

💬 16   🔁 12   ♡ 164   ✉

Josh Constine ✅ @JoshConstine · Nov 22 ⌄
Thanks for doing your part and please let me know how this goes. If he
wants an unregulated internet, he might not like what he gets

💬 2   🔁 1   ♡ 51   ✉

Matthew Prince ✅ @eastdakota · Nov 22 ⌄
indeed.

💬 3   🔁   ♡ 51   ✉

AEI

Daniel Lyons
@ProfDanielLyons
April 2, 2018 6:00 am | *AEIdeas*

Paid prioritization: Debunking the myth of fast and slow lanes

Technology and Innovation, Telecommunications

Last week, on a panel at the Free State Foundation's always excellent Annual Telecom Policy Conference, Cisco Systems Vice President Jeffrey Campbell highlighted that paid prioritization is "one of the most misunderstood issues" in the telecom policy space. His concerns match a recent op-ed by Sen. Lisa Murkowski (R-AK), which reiterated the importance of the open internet but nonetheless discussed the value of prioritization in capacity-constrained areas such as rural Alaska.

Via Twenty20

Both Murkowski's and Campbell's remarks reflect a growing realization that prioritization can play a positive role in network traffic management. But to understand why, we need to get beyond the "fast lanes, slow lanes" metaphor that has too often dominated the net neutrality debate.

The myth of fast lanes and slow lanes

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Net neutrality advocates often argue that without a ban on paid prioritization, internet service providers (ISPs) would divide the network into "a fast lane for those who can afford it — and a slow lane for the rest of us." Playing, perhaps, on the 1990s imagery of the internet as an "information superhighway," this rhetoric envisions broadband networks as segmented into various lanes of travel, with packets sorted into channels that move at different maximum speeds at all times.

But as Campbell explained, this is a myth. All internet traffic on a network moves at the same speed — the speed at which the electrons propagate on the wire. The problem is congestion: what happens when users want to transmit more data than the wire can physically manage at a particular moment. In this case, the network must drop some packets and allow others to go through. The dropped packets then must be resent, which delays the delivery of the service.

The inevitability of congestion and the danger of prioritization bans

Of course, congestion is not constant; it is more likely to occur at times of peak use. The solution to chronic congestion is to expand network capacity. But additional capacity is expensive. It is often uneconomic to build a network with zero congestion at peak time because this would create significant excess capacity at off-peak periods. And a zero-congestion network today may nonetheless face congestion in the future, as consumers' appetites for data grow. So some amount of congestion is inevitable.

So how can we address that congestion? One can drop packets randomly, which seems to align with net neutrality's ethos that all traffic should be treated the same. But there's a problem with this model: Different internet content and applications have different susceptibility to congestion. A user loading an email or a webpage is unlikely to notice if some packets are dropped and resent. But streaming video or FaceTime may buffer, which erodes the consumer's experience and makes the product less reliable. As Campbell notes, an alternative would be to drop packets intelligently, by deprioritizing traffic that is less sensitive and prioritizing traffic that is more sensitive to congestion. This would improve the experience for streaming video (for example) without measurably degrading the web surfer's experience.

See also: States join the net neutrality #resistance: Will it make a difference? (https://www.aei.org/publication/states-join-the-net-neutrality-resistance-will-it-make-a-difference/)

Importantly, Campbell explained that a ban on prioritization is effectively a ban on internet-based services that are sensitive to congestion. Without the ability to secure a minimum quality-of-service guarantee, an edge provider of a congestion-sensitive service is less able to deliver its product to consumers. Murkowski highlights the importance of telemedicine and tele-education applications, both

of which involve congestion-sensitive video transmissions that suffer when all traffic is treated

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"equally" at congested nodes. As Murkowski explains, the inability to prioritize congestion-sensitive traffic most adversely affects rural areas, where these video applications are useful and where capacity-constrained networks may experience congestion more often. But Campbell's point is that prioritization bans affect all of us, by deterring innovators from developing new internet-based services that need some protection from congestion.

The role of price

When pressed, some net neutrality advocates will concede the value of intelligent traffic management. The problem isn't prioritization, they claim, but paid prioritization: the protection against congestion in exchange for a fee.

But once one acknowledges the need to prioritize traffic, one then needs a method of prioritization. One solution is a central planning model: An expert (likely either a government bureaucrat or a broadband company engineer) can develop a master list of all internet-based applications and sort it by priority. This raises difficult questions about the sorting rule. Is it based entirely on how quickly the service erodes, or is the expert choosing, say, telemedicine over cat videos because he or she feels telemedicine is more important? This raises the prospect of government or ISPs picking winners and losers, which is precisely what net neutrality is supposed to prevent. The expert may miscalculate an application's sensitivity. And even if the expert gets the list right, it's hard to maintain in a dynamic environment where new services are being added and existing services are being improved, which makes today's congestion-sensitivity calculations less relevant tomorrow.

Alternatively, we can use the price mechanism, which is the way we generally allocate scarce resources (like bandwidth) in a capitalist society. Hayek taught that prices reveal information that markets can use to sort claims on a decentralized basis. An edge provider will only purchase prioritization if its service is congestion-sensitive. When it is willing to do so, and at what price, reveals how susceptible it is compared to other apps. This sorts apps with less error and fewer value judgment than a centrally planned solution.

The concern, of course, is that the price mechanism harms those who cannot afford to pay for prioritization. But these concerns are somewhat overrated. First, apps that are not congestion-sensitive have no need to pay for prioritization. Second, even in a net-neutral world, there are other ways that well-funded companies can — and do — pay to reduce their exposure to congestion, such as using content delivery networks to bypass the public internet. Finally, although players have incentives to use prioritization in an anticompetitive manner, antitrust law protects consumers from such harm, just as it shields us from anticompetitive conduct elsewhere in the American economy.

It's always difficult to understand telecom policy by metaphor, as anyone knows who has tried to teach the *Brand X* case's distinction between Justice Thomas's internet-as-car-dealership analogy and Justice

Scalia's preferred conception of internet-as-pizza-delivery. Too often, metaphors are taken too literally

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in ways that harm the policy debate. I share Campbell's hope that we can move beyond the misleading fast lanes/slow lanes metaphor, which hides the significant potential benefits of prioritization to consumers and app developers alike.

Learn more: After the vote: What's next for the Restoring Internet Freedom Order (https://www.aei.org/publication/after-the-vote-whats-next-for-the-restoring-internet-freedom-order/,

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Federal Communications Commission (FCC), Innovation, Net neutrality, Regulation, Telecommunications

PERSPECTIVES

Reclassification and Investment:

An Analysis of Free Press' "It's Working" Report

Dr. George S. Ford*

May 22, 2017

Introduction

Free Press, a zealous proponent of Internet regulation, recently released a report on the capital expenditures of broadband service providers entitled, *It's Working: How the Internet Access and Online Video Markets are Thriving in the Title II Era* (hereinafter *"Free Press Report"*).[1] The *Free Press Report*, authored by S. Derek Turner, claims that capital spending by Broadband Service Providers ("BSPs") "accelerated" following the Federal Communications Commission's ("FCC") reclassification of broadband Internet access connections as a Title II common carrier telecommunications service in its *2015 Open Internet Order*, increasing by 5.3% between 2013-2014 and 2015-2016.[2] The Internet Alliance, a trade group representing the interests of companies supporting reclassification, appears to use the Free Press' data to support the same claim.[3]

Free Press' analysis, as usual, fails to meet the most basic of professional standards, and involves nothing more than the adding up of nominal total capital expenditures for a sample of BSPs and comparing the sums between two periods. Such simple-minded analysis is incapable of measuring the effect of a policy change.[4] The relevant question is not whether capital spending rises or falls in any given year or pair of years, but whether such expenditures are below the levels they would have been "but for" the regulatory intervention. To answer that question, we need a counterfactual. That is, if absent a regulatory intervention capital spending was scheduled to rise by 10% next year (the counterfactual), but rises by only 5% due to an intervention, the intervention reduces investment despite the fact expenditures were higher. Unlike recent research finding sizable harmful effects from reclassification, the *Free Press Report* offers no counterfactual, so their *Report* adds nothing serious to the analysis of Net Neutrality and reclassification.[5]

> *Free Press' analysis, as usual, fails to meet the most basic of professional standards, and involves nothing more than the adding up of nominal total capital expenditures for a sample of BSPs and comparing the sums between two periods. Such simple-minded analysis is incapable of measuring the effect of a policy change.*

That said, the *Free Press Report* does add something to the debate. Once the most basic adjustment to the data is made—accounting for inflation—Free Press' data show that capital spending fell significantly in 2016 (-2%). Had investment grown in 2016 by the amount claimed

in the *Free Press Report* (another 3.5% in 2016), the difference between the predicted and actual capital spending would be $4 billion. Free Press' own data, therefore, provides support for the $3.7 to $5.1 billion investment decline cited by Chairman Pai when announcing his intent to review of the *2015 Open Internet Order*.[6] Like recently released data by USTelecom and CTIA, multiple sources are finding substantial declines in capital spending in 2016.[7] While Free Press wishes to peddle the fairy tale of positive investment effects, in fact their *Report* demonstrates that reclassification has been a nightmare for the rest of us.

Once the most basic adjustment to the data is made—accounting for inflation—Free Press' data shows that capital spending fell significantly in 2016 (-2%). *** While Free Press wishes to peddle the fairy tale of positive investment effects, in fact their Report demonstrates that reclassification has been a nightmare for the rest of us.

Free Press Shows a Decline in Investment

As Free Press has done in the past, its most recent *Report* draws strong conclusions about investment based on the flimsiest of evidence.[8] For example, Free Press compares the sum of 2013-2014 capital expenditures (in nominal dollars) to 2015-2016 capital expenditures, reporting a 5.3% increase.[9] Absent a counterfactual, such evidence says nothing about the policy change. Also, the FCC's *Open Internet Order* was released in March of 2015, long after investment decisions were made for that year (and perhaps a few more years out).

Separating the data into annual spending and adjusting for inflation tells a much different story

than that offered in the *Free Press Report*. Table 1 summarizes the *real* capital expenditures for the BSPs on a year-to-year basis.[10] As shown in the Table 1, capital expenditures rise between 2013 and 2014, and again rise between 2014 and 2015. However, the year after the 2015 reclassification decision, capital spending fell by nearly 2%, or $1.3 billion. Investment after the *2015 Open Internet Order* is, in fact, down. This decline in expenditures is hidden by Free Press' summing of 2015 and 2016 capital expenditures data and by their failure to adjust for inflation.[11]

Table 1. Change in Capital Expenditures (2013-2016)

Year	Capital Expenditures (2015 dollars)	Change from Prior Year (%)
2013	$71,106,649	...
2014	$71,429,876	0.6%
2015	$73,738,162	3.2%
2016	$72,394,467	-1.8%

Source: Free Press Study; Author's Calculations.

The decline in capital spending demonstrated by Free Press is consistent with recent data from other industry sources. CTIA, for instance, showing a stunning 17% decline in real capial spending between 2015 and 2016.[12] Estimates of capital spending constructed by USTelecom, which are at present preliminary, also indicate that capital spending declined between 2016 and 2015.[13] These data are summarized in Table 3. For once, all sides of the debate agree—capital spending is down in 2016.

Table 3. Investment Growth into 2016

Year	Free Press	CTIA	USTelecom
2014	0.6%	-3.0%	0.1%
2015	3.2%	0.0%	-1.7%
2016	-1.8%	-17.0%	-4.5%

Of course, investment levels vary year-to-year for a variety of reasons, sometimes substantially. In

some cases, it is the FCC's "objectionable and questionable" actions that alter investment levels.[14] As a consequence of the FCC's Direct-TV merger *Order*, for instance, the Commission is forcing AT&T to make substantial investments in building network to places it may not have gone otherwise.[15] The Charter-Time Warner merger included similar conditions.[16] Such mandates show up in capital spending but do not reflect genuine economic incentives or necessarily increase social well-being. The true effects on investment of reclassification are hard to decipher given former FCC Chairman Tom Wheeler's forceful attempts to cover up such effects using what amounts to extortion during merger reviews.[17]

Anything Useful from the Data?

Two interesting questions come to mind when looking at the decline in investment indicated by the Free Press data. First, does this $1.3 billion decline in investment measure the true effect of reclassification, or is the actual investment effect smaller or larger? Second, is the 1.8% decline in capital spending consistent with the annual variability in capital spending or is it extraordinary in its size? Free Press answers neither question.

> *... the year after the 2015 reclassification decision, capital spending fell by nearly 2%, or $1.3 billion. *** This decline in expenditures is hidden by Free Press' summing of 2015 and 2016 capital expenditures data and by their failure to adjust for inflation.*

With such limited data, it is difficult to say much of anything about the effects of reclassification on capital spending, since so little data precludes the construction of a counterfactual. All we really

know from the *Free Press Report* is the capital spending fell in 2016. If capital spending in 2016 would have grown by the amount claimed in the *Free Press Report* (5.3%), investment would have increased by 3.5% in 2016, then total spending in that year would have been $77.3 billion.[18] The loss in capital spending from reclassification is nearly $4 billion dollars.

In support of its new *Report*, Free Press' press release barked: "Sorry, Chairman Pai: Your Investment Numbers Don't Add Up."[19] Yet, Chairman Pai's claims of a $3.7 to $5.1 billion reduction in capital spending following reclassification is entirely consistent with the data and claims of the *Free Press Report*.[20] Rather than rebuttal, Free Press' data supports Chairman Pai's claims (at least under the assumptions I've made).

Conclusion

While the central problem with the FCC's reclassification decision is legal, the debate over the investment effects rage on.[21] Free Press' latest entry into the controversy claims to show that investment has risen since the reclassification decision. Yet, the Free Press data indicate otherwise: investment in 2016 is down, and down $4 billion below the political-interest group's claim. The downward move in capital spending is consistent with the investment estimates by other industry sources.

> *In support of its new Report, Free Press' press release barks: "Sorry, Chairman Pai: Your Investment Numbers Don't Add Up." *** Rather than rebuttal, Free Press' data supports Chairman Pai's claims...*

While Free Press hoped its study would counter Chairman Pai's recent observation that investment in the industry in down after

reclassification, their *Report* actually lends support to the Chairman's claims. Perhaps inadvertently, Free Press has added to the growing body of evidence of the harmful effects of Title II on industry investment. That said, my official position is that Free Press' analysis is too poorly done and their data are too limited to say much of anything about the policy effects of Net Neutrality or reclassification.

NOTES:

*   **Dr. George S. Ford** *is the Chief Economist of the Phoenix Center for Advanced Legal and Economic Public Policy Studies. The views expressed in this Perspective do not represent the views of the Phoenix Center or its staff. Dr. Ford may be contacted at ford@phoenix-center.org.*

[1]   S. Derek Turner, *It's Working: How the Internet Access and Online Video Markets are Thriving in the Title II Era*, Free Press (May 2017) (available at: https://www.freepress.net/sites/default/files/resources/internet-access-and-online-video-markets-are-thriving-in-title-II-era.pdf).

[2]   *Id.* at p. 2; *Protecting and Promoting the Open Internet*, REPORT AND ORDER ON REMAND, DECLARATORY RULING AND ORDER, GN Docket No. 14-28, FCC 15-24, 80 Fed. Reg. 19738 (rel. Mar. 12, 2015) (hereinafter "*2015 Open Internet Order*"), *aff'd, United States Telecom Association v. FCC*, 825 F.3d 674 (D.C. Cir. 2016), *pet. for rehearing en banc denied*, __ F.3d __ (May 1, 2017).

[3]   INTERNET ASSOCIATION REPORTS: PRELIMINARY NET NEUTRALITY FINDINGS, Internet Association (available at: https://internetassociation.org/net-neutrality-facts) (claiming a 5.3% "increase in telecom investment among Publicly traded companies from 2013-2014 to 2015-2016").

[4]   *See, e.g.,* J.D. Angrist and J.S. Pischke, MOSTLY HARMLESS ECONOMETRICS: AN EMPIRICIST'S COMPANION (2008).

[5]   G.S. Ford, *Net Neutrality, Reclassification and Investment: A Counterfactual Analysis*, PHOENIX CENTER POLICY PERSPECTIVE No. 17-02 (April 25, 2017) (available at: http://phoenix-center.org/perspectives/Perspective17-02Final.pdf); G.S. Ford, *Net Neutrality, Reclassification and Investment: A Further Analysis*, PHOENIX CENTER POLICY PERSPECTIVE No. 17-03 (May 16, 2017) (available at: http://phoenix-center.org/perspectives/Perspective17-03Final.pdf).

[6]   Remarks of FCC Chairman Ajit Pai at the Newseum (Washington, DC), *The Future of Internet Freedom* (April 26, 2017) (available at: http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0426/DOC-344590A1.pdf). The $3.7 billion figure is for 12 firms, but the largest 12 firms make up nearly all the total industry investment.

[7]   P. Brogan, *Broadband Investment Heads in the Wrong Direction*, USTELECOM BLOG (May 5, 2017) (available at: http://www.ustelecom.org/blog/broadband-investment-heads-wrong-direction). More detail was provided in a telephone conservation with Patrick Brogan (May 19, 2017); *Annual Year-End 2016 Top-Line Survey Results*, CTIA (May 2017) (available at: https://www.ctia.org/docs/default-source/default-document-library/annual-year-end-2016-top-line-survey-results-final.pdf?sfvrsn=2).

[8]   *See, e.g.,* G.S. Ford, *Finding the Bottom: A Review of Free Press's Analysis of Network Neutrality and Investment*, PHOENIX CENTER PERSPECTIVE No. 09-04 (October 29, 2009) (available at: http://www.phoenix-center.org/perspectives/Perspective09-04Final.pdf).

[9]   *Free Press Report, supra* n. 1 at Figure A1.

[10]   Nominal values are converted to 2015 dollars using the GDP deflator (available at: https://fred.stlouisfed.org/series/GDPDEF#0).

[11]   It may be, of course, that 2015 is the peculiarity here, not 2016.

[12]   CTIA, *supra* n. 7.

[13]   Brogan, *supra* n. 7.

[14]   Statement of Commissioner Michael O'Reilly, *In the Matter of Applications of Charter Communications, Inc., Time Warner Cable Inc., and Advance/Newhouse Partnership*, FCC 17-34, ORDER ON RECONSIDERATION, __ FCC Rcd __ (rel. April 3. 2017) (available at: https://apps.fcc.gov/edocs_public/attachmatch/FCC-17-34A4.pdf).

[15]   *See* T.R. Beard, G.S. Ford, L.J. Spiwak, and M. Stern, *Eroding the Rule of Law: Regulation as Cooperative Bargaining at the FCC*, PHOENIX CENTER POLICY PAPER NO. 49 (October 2015) (available at: http://www.phoenix-center.org/pcpp/PCPP49Final.pdf).

[16]   J. Eggerton, *FCC Votes to Reverse Charter Overbuild Condition*, BROADCASTING & CABLE (April 3, 2017) (available at: http://www.broadcastingcable.com/news/washington/fcc-votes-reverse-charter-overbuild-condition/164581).

[17]   *See Charter Order on Reconsideration, supra* n. 13 at ¶ 8 ("The Commission's transactional review is not an opportunity for the Commission to advance unrelated policy objectives by extracting commitments from the transacting parties in exchange for regulatory approval.") (available at: https://apps.fcc.gov/edocs_public/attachmatch/FCC-17-34A1.pdf); *see also* Beard *et al., supra* n. 11.

[18]   This figure assumes an average 5.3% growth rate between 2013-2014 and 2015-2016.

PERSPECTIVES

NOTES CONTINUED:

[19]   D. Floberg, *Sorry, Chairman Pai: Your Investment Numbers Don't Add Up*, Free Press Press Release (May 17, 2017) (available at: https://www.freepress.net/blog/2017/05/17/sorry-chairman-pai-your-investment-numbers-dont-add).

[20]   Remarks of Chairman Pai, *supra* n. 6.

[21]   G.S. Ford and L.J. Spiwak, *Tariffing Internet Termination: Pricing Implications of Classifying Broadband as a Title II Telecommunications Service*, 67 FEDERAL COMMUNICATIONS LAW JOURNAL 1-19 (2015) (available at: http://www.fclj.org/wp-content/uploads/2015/02/Tariffing-Internet-Termination.pdf).

ONE HUNDRED FIFTEENTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON ENERGY AND COMMERCE

2125 RAYBURN HOUSE OFFICE BUILDING
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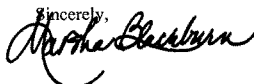Majority (202) 225–2927
Minority (202) 225–3641

May 2, 2018

Mr. Richard Bennett
Founder
High Tech Forum
869 South Cole Drive
Lakewood, CO 80228

Dear Mr. Bennett:

Thank you for appearing before the Subcommittee on Communications and Technology on Tuesday, April 17, 2018, to testify at the hearing entitled "From Core to Edge: Perspective on Internet Prioritization."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for ten business days to permit Members to submit additional questions for the record, which are attached. To facilitate the printing of the hearing record, please respond to these questions with a transmittal letter by the close of business on Wednesday, May 16, 2018. Your responses should be mailed to Evan Viau, Legislative Clerk, Committee on Energy and Commerce, 2125 Rayburn House Office Building, Washington, DC 20515 and e-mailed to Evan.Viau@mail.house.gov.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Marsha Blackburn
Chairman
Subcommittee on Communications and Technology

cc: The Honorable Michael F. Doyle, Ranking Member, Subcommittee on Communications and Technology

Attachment

HighTech
FORUM

High Tech Forum
869 South Cole Drive
Lakewood, Colorado

United States House of Representatives

Committee on Energy and Commerce

Subcommittee on Communications and Technology

April 17, 2018

Responses to Additional Questions

Richard Bennett

The Honorable Marsha Blackburn:

Please find my answers to your additional questions following. Thank you again for allowing me to testify before your committee.

1. During the hearing, pre-emption and prioritization over the FirstNet network were used as examples of public safety applications that could benefit from prioritization. Can you elaborate on the need for prioritization and optimization among other applications?

Prioritization is necessary in packet switched networks in order to make the best use of network bandwidth. These networks rely on statistical multiplexing, a technique that shares communication channels with multiple users and multiple applications. This is similar to grocery store checkout lines. While the channel or line may have an average delay that's tolerable to the customer, there are always some periods of time in which a number of users happen to show up at the same time. This increases delay for all.

Network management is capable of re-ordering information packets in such a way that the applications that require low delay can obtain it; these are typically voice and conferencing applications. Re-ordering information packets in this way adds subtle delays to non-prioritized information, but this delays are typically small enough that they're not noticed by consumers.

This is an information processing-intensive task that goes over and beyond the basic requirements of telecommunication service; it is therefore reasonable for firms to charge for performing the service.

In the case of FirstNet, video communication is often necessary for assessing the situation on the ground. If a dispatcher in the headquarters location needs to see, for example, the water flow in a river swollen with heavy rain, glitches in the video stream can create false impressions. It's therefore important for these pictures to be transmitted in real time with a minimum of delay and variation.

Applications such as Aira have a very similar challenge, as video glitches caused by excessive delay or packet loss impair the guide's ability to direct the user.

2. From a network engineering perspective, can you describe what a "user-directed" prioritization or optimization environment might look like?

    a. How would the user implement their choice to optimize or prioritize certain services or applications?

User-directed prioritization requires communication in the form of messages from the user to the network service provider. This can take place in a number of ways, all of which require an application to send the message:

1. The user may have access to a web page that allows them to identify the applications in need of prioritization. This would be similar to the configuration pages in home routers that allow the user to configure Quality of Service options. One unresolved question is how the user would identify inbound data streams in order to specify their treatment.

   The simple solution, often promoted by advocates of heavy Internet regulation, would rely on IP addresses. But services requiring special treatment do not always come from known IP addresses, and not all traffic from any given IP address requires special treatment. The same problems exist for domain names; google.com represents a large number of different services.

   Other approaches would rely on the ISP doing packet inspection (AKA "deep packet inspection") or heuristics such as packet length, frequency, or port numbers. The only reasonable solution requires services to stick to known domains or IP addresses in combination with restricted port numbers and other factors. In most cases, the user will need to know several pieces of information that will sound mysterious and complicated to the average consumer.

2. The application the user wishes to prioritize – such as a video conferencing application – can also send a message to the ISP requesting special treatment. In engineering, this is known as an "Admission Control" message. These messages function like concert tickets, verifying that the party is authorized to enter the theater and occupy a certain seat. The Admission Control message will typically operate in conjunction with a web authorization or similar technique. This is the method used by Wi-Fi and by the Internet's Integrated Services standard.[1]

   Admission Control messages need to be authenticated in real time, a process that's reasonable when performed between the ISP and the service, but unreasonable when the consumer's direct consent is needed for each such transaction. This practice can only be made to conform with the user consent requirement by delegating real-time

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[1] R. Braden, D. Clark, and S. Shenker, "RFC 1633 - Integrated Services in the Internet Architecture: An Overview" June 1994, http://tools.ietf.org/rfc/rfc1633.txt.

processing to the ISP and forcing cooperation between the application provider and the ISP.

3. The message can be embedded in information packets sent by the ISP user to the service of their choice and also in the packets sent by the service to the user. This is the method specified by the Internet's Differentiated Services protocol.[2] It is also used by IEEE 802 standards for Ethernet (802.1D) and W-Fi (802.11e).[3] This method is not exclusively user-controlled since the user has no ability to embed signals in the information passing from the service to the user; the user can only control the messages he or she sends. Hence, the use of this service requires communication between the user and the ISP to authorize the service's use of priority signaling.

   In practice, this is very complicated. For practical use, it's most convenient for the user to delegate signaling and authorization to a third party application to manage on the user's behalf. Many features of the Internet assume a high level of technical knowledge in the part of the user because it was originally a research network. In today's world, users often have very little network management knowledge, so decisions that affect network operation and leading-edge application performance are best left to experts.

   One of the leading advocates for "user-controlled prioritization" is Barbara van Schewick of the Stanford Center for Internet and Society. She presented a paper at the TPRC Conference in 2010 making the argument that users alone should be allowed to make prioritization decisions.[4] When I asked her if users should be allowed to delegate this power to ISPs and third party application providers, she answered that she didn't know and would have to think about it. I'm still waiting for her answer.

Thank you for the opportunity to answer these questions and please feel free to contact me in the future.

Sincerely yours,

/signed/ Richard Bennett

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[2] S. Blake et al., "RFC 2475 - An Architecture for Differentiated Services" December 1998, http://tools.ietf.org/rfc/rfc2475.txt.

[3] IEEE Computer Society et al., *IEEE Std 802.11e™-2005: IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems--Local and Metropolitan Area Networks--Specific Requirements. Part 11, Amendment 8, Part 11, Amendment 8,* (New York, NY: Institute of Electrical and Electronics Engineers, 2003), http://ieeexplore.ieee.org/servlet/opac?punumber=10328; IEEE Computer Society; International Electrotechnical Commission; International Organization for Standardization; Institute of Electrical and Electronics Engineers; IEEE Standards Board, *IEEE Std 802.1D™- 2004* (New York, N.Y. USA: Institute of Electrical and Electronics Engineers, 2004), 1.

[4] Barbara van Schewick, "Network Neutrality: What a Non-Discrimination Rule Should Look Like," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, September 20, 2010), https://papers.ssrn.com/abstract=1684677.