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ELECTRONIC FRONTIER FOUNDATION'S COMMENTS REGARDING US TELECOM PETITION FOR FORBEARANCE

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Ernesto Falcon
Erica Portnoy
Electronic Frontier Foundation
815 Eddy Street
San Francisco, CA 94109

The FCC Must Explore Why Telecom Carriers Have Failed to Launch Fiber to the Home to Compete with Cable Companies in the High-Speed Broadband Market

Fiber to the home (FTTH) is a proven network architecture that can scale and be upgraded at comparatively low costs while providing tremendous capacity for future Internet innovations. Unfortunately, the Federal Communication Commission's data indicates that a staggering 85 percent of Americans have either no choice or one choice for broadband services that exceed 100 Mbps—because no carrier offers them fiber. In barely 10 percent of the US market do consumers have access to a FTTH competitor to the local cable company, which means the combination of Verizon FiOS, Google Fiber, Competitive Local Exchange Carriers, and publicly owned fiber networks[1] serve as competitive choices for high-speed Internet for very few Americans.

In the past, the agency found the market to be competitive due to competition between different networks such as DSL, cable modems, satellite, and wireless. With the benefit of hindsight we can see that the cable companies are effectively unchallenged in most of the US high-speed broadband market because their telephone rivals have no plans to aggressively deploy FTTH to compete or prospectively address their congestion concerns. In fact, nearly half of American deployment in FTTH has fallen on the shoulders of small budget niche players in isolated markets.[2] The complete absence of nationwide FTTH deployment plans by major ISPs should alarm the FCC because it has happened after the Restoring Internet Freedom Order and additional billions in corporate profits thanks to the tax cuts from Congress.[3]

The problem appears to be that the lack of competition in high-speed Internet access has allowed the cable industry to approach monopoly status for broadband speeds above 100 mbps. Cable companies have no incentive to upgrade to speeds of a gigabit or higher as their main rival, telephone companies, have done little more than upgrade their DSL lines to middle-tier speeds of 25 mbps these last few years. Wireless and satellite do not appear proven as competitive alternatives at these speeds, and for good reason that we explain below. As for rural markets that present unique challenges to obtaining competitive high-speed choice, new deployments by wholesale providers overseas could provide useful insights as to how we can ensure rural Americans get both high-speed access and competition.

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[1] *See* INSTITUTE FOR LOCAL SELF-RELIANCE, *Community Network Map*, available at https://muninetworks.org/communitymap.

[2] Krista Tysco, *A Mid-Year Roundup of the 2017 Global FTTH Broadband Market*, PPC BROADBAND, PPC BLOG, Aug. 3, 2017, *available at* http://www.ppc-online.com/blog/a-mid-year-roundup-of-the-2017-global-ftth-broadband-market.

[3] Tax Cuts and Jobs Act of 2017, Pub. L. No. 115-97, 131 Stat. 2054; *See also* Ryan Knutson & Austen Hufford, *Verizon to Pay Down Debt, Given Employees Stock Awards with Tax Windfall*, WALL ST. J., Jan. 23, 2018, *available at* https://www.wsj.com/articles/verizon-dials-up-wireless-revenue-growth-1516714601 (reporting an extra $ 4 billion of cash on hand for Verizon); *See also* Reuters & Fortune Editors, *AT&T Is the Latest Company to Report a Tax Reform Windfall*, FORTUNE, Feb. 1, 2018, *available at* http://fortune.com/2018/02/01/att-earnings-tax-reform (reporting an extra $3 billion of cash on hand from Congress cutting corporate taxes).

The Technical Advantages of Fiber Demonstrates Why it is the Clearly Superior Choice of Connectivity Medium for Broadband Communications

For both copper and fiber, the basic principle of operation is the same. A cable is laid between two endpoints. The origin quickly taps out a sequence. This sequence of taps is read out at the other end. The faster the taps, the more information is received at the other end per unit time. This is referred to as a "frequency" of the data.

The frequency itself is only the first clue to understanding the total potential bandwidth, though, because a technology called "multiplexing" allows multiple frequencies to be sent over the same wire simultaneously. While there are infinite frequencies in any given range, each of which could carry its own data, the physical properties of the medium limit the number of separate "channels" that can be sent over a wire simultaneously. Frequencies that are too close will essentially blend into each other when sent over an imperfect medium.

Essentially, bandwidth depends on how quickly information can be sent along a single channel, and how many distinct channels can fit into a single cable. Therefore, the range of frequencies that a cable can support becomes vital to understanding the total bandwidth of a cable. The maximum theoretical bandwidth of a cable is a function of the range of frequencies that can be sent over that cable, along with the signal-to-noise ratio for that range.

For both of these two critical factors—the range of frequencies available and the signal-to-noise ratio—fiber is superior to copper wire infrastructure used by both cable and telephone. For example, fiber optic cables carry information in the optical range of 400-800 THz, whereas copper transmits at the radio frequency range of up to 5000 MHz. Sending a higher frequency signal along a cable increases the amount of noise in a channel, and it does so much more punishingly for electrical signals being sent along a copper wire than for optical signals being sent along a fiber optic cable.

Copper cannot operate at higher frequencies because information degenerates more rapidly as frequency increases. Existing copper cables lose 92.8dB/km at the maximum end of their range (5000 MHz)[4]; operating at any higher frequency would only be useful at exceedingly small distances. In contrast, fiber optic cables operate at frequencies tens of thousands of times higher, and lose only 0.2 dB/km.[5] This also means that fiber optic cables are suitable for longer distance communications, thus requiring less equipment infrastructure to operate.

In practice, data does not get sent at this limit, but technological advancements in endpoint technology push us closer to that limit without replacing the existing cables. Current research focuses on how to build a device to insert data at as many frequencies as possible into the medium, to achieve bandwidths closer the theoretical limits of both copper and fiber optic cables.

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[4] RADIO FREQUENCY SYSTEMS, *Product Datasheet*, available at http://products.rfsworld.com//WebSearchECat/datasheets/pdf/cache/LCF78-50JFNA-A0.pdf.

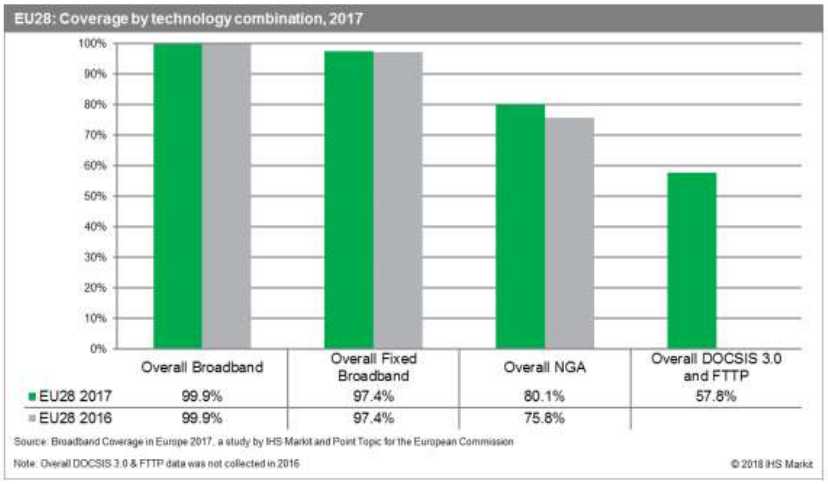
[5] CORNING, *Optical Fiber Product Portfolio*, available at http://www.corning.com/media/worldwide/coc/documents/Fiber/COF-006-AEN.pdf.

Previously, though the medium of optical fiber itself was understood to be significantly better for transmitting data, it was hard and expensive to build the cables to reach anywhere near that capacity. Now, technology is starting to catch up to the medium's true capacity. A 2018 study managed to put 159 Tb/s in a fiber optic cable over a thousand kilometers long.[6]

Wireless broadband faces even more challenges to be on par with FTTH. For wireless transmissions, factors such as weather, physical obstructions, distance, power levels, and competing transmissions over the same space all interfere with its ability to transmit data. The frequency that is being used for transmission also has an impact on the amount of data that can be transmitted, the distance it can travel, and its capacity to penetrate obstacles. A basic rule of thumb is the higher the frequency of the spectrum band that is being used, the more difficulty it has passing through objects. Put another way, the radio waves we use for wireless technologies are the same type of energy as light waves that come from a flashlight (it just operates at a much lower frequency beyond visible range). In fact, we can see that from demonstrations of lamps being used to transmit high-definition video quality data transmissions.[7]

Comparing the U.S. Market to the International Markets Reveals the Extent the Last Mile is Starved of Potential Capacity by Lack of Deployment

Today, approximately 57.8 percent of Europeans have access to DOCSIS 3.0 and FTTP (the EU term that is equivalent to FTTH) with FTTP reaching 26.8 percent of EU homes and DOCSIS 3.0 reaching 44.7 percent of homes. The aggregate number demonstrates how the American market is behind our European counterparts even when not every EU nation is on track to meet their metrics of universal coverage of 30 Mbps and 50 percent coverage of 100 Mbps and above by 2020.[8]



[6] Sachiko Hirota, *Record Breaking Fiber Transmission Speed Reported*, PHYS.ORG (Apr. 16, 2018), available at https://phys.org/news/2018-04-fiber-transmission.html.
[7] Harold Hass, *Wireless data from every light bulb*, Technology, Entertainment, Design (TED) Global 2011 (Jul. 2011), http://www.ted.com/talks/harald_haas_wireless_data_from_every_light_bulb?language=en.
[8] EUROPEAN COURT OF AUDITORS, *Broadband in the EU Member States: Despite Progress, not All the Europe 2020 Targets Will be Met, available at* https://www.eca.europa.eu/Lists/ECADocuments/SR18_12/SR_BROADBAND_EN.pdf.

When we explore individual member states of the EU, we find that the aggregate number masks extraordinary advancements across the Pacific that show how far behind American deployment truly is today. For example, FTTP in Portugal, Latvia, Lithuania, and Spain exceed 70 percent coverage. Spain in particular has enjoyed an extraordinary rise in FTTH coverage with a growth of 8.6 percent for 2017[9] as a result of a commercial co-investment and network sharing agreements.[10]

In fact, every EU member except for Ireland, Germany, the United Kingdom, Belgium, and Greece is ahead of the United States in FTTH deployment, and even among those lagging nations, an active rethinking or new implementation of telecom policy is occurring to address their lagging performance. For example, Ireland's fiber growth has exploded at a meteoric 419.6% increase from 2016-2017 as a result of "wholesale only" initiatives.[11] The United Kingdom is currently using structural separation remedies with British Telecom to address their current lack of fiber deployment.[12]

Ahead of even the best performing EU nations, though, is South Korea—with near universal deployment of fiber connections to the home.[13] Such connectivity was on display during the 2018 Winter Olympics when a year in advance their ISPs launched a plan to deploy the first 5G networks.[14] Such networks are reliant on fiber and were showcased during the games. Near universal coverage by fiber also allowed Korea Telecom to deploy 3D virtual reality viewing of the games[15] and support self-driving mass transit,[16] things that are simply not supportable with current U.S. infrastructure.

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[9] EUROPEAN COMMISSION, *Broadband Coverage in Europe 2017*, *available at* https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2017.

[10] Enrique Medina, *Why Spain is a Case Study for Super-Fast Broadband*, TELEFONICA, Nov. 20, 2017, available at https://www.telefonica.com/en/web/public-policy/blog/article/-/blogs/why-spain-is-a-case-study-for-super-fast-broadband.

[11] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, *Penetration and Data Usage (Growth of fibre subscriptions Dec. 2017)*, *available at* http://www.oecd.org/sti/broadband/1.11-FibreGrowth-2017-12.xls; *See also Wholesale Only Model Study supra* note 29.

[12] Ilsa Godlovitch, Bernd Sorries, & Tseveen Gantumur, *A Tale of Five Cities: The Implications of Broadband Business Models on Choice, Price and Quality*, WIK-CONSULT, Jun. 2, 2017, *available at* https://www.stokab.se/Documents/Nyheter%20bilagor/A%20tale%20of%20five%20cities.pdf

[13] Krista Tysco, *A Mid-Year Roundup of the 2017 Global FTTH Broadband Market*, PPC BROADBAND, PPC BLOG, Aug. 3, 2017, *available at* http://www.ppc-online.com/blog/a-mid-year-roundup-of-the-2017-global-ftth-broadband-market (most noteworthy in this analysis is the role smaller ISPs play in deploying FTTH where nearly 50 percent of the growth in fiber is attributable to CLECs and local government).

[14] Erwan Lucas, *In South Korea, the Race is on for Olympics 5G Next Year*, PHYS.ORG, Feb. 28, 2017, *available at* https://phys.org/news/2017-02-south-korea-olympics-5g-year.html.

[15] Cho Mu-Hyun, *KT to Provide 360 Degree VR for 2018 Winter Games*, ZDNET, Feb. 15, 2016, *available at* https://www.zdnet.com/article/kt-to-provide-360-degree-vr-for-2018-winter-games/

[16] Diamond Leung, *2018 PyeongChang Olympics Has 5G-Enabled VR, Live Holograms, Self-Driving Buses, Drones*, SPORTTECHIE, Mar. 28, 2017, *available at* https://www.sporttechie.com/2018-pyeongchang-olympics-has-5g-enabled-vr-live-holograms-self-driving-buses-drones.

The FCC Should Investigate the Potential of Wholesale Fiber Providers Bringing Competitive High-Speed Broadband to Rural America

Recent developments in the international markets have shown the ability of wholesale fiber networks that do not sell retail broadband service to overcome infrastructure cost barriers that plague retail broadband providers. This appears to happen because a wholesale provider has access to longer-term loans that are more attuned to high sunk costs and thus better suited to handle connecting residents and businesses to a fiber network by spreading the costs over many years.[17] Wholesale providers' access to longer term financing more accustomed to funding infrastructure that comes with a longer window on returns allows greater flexibility and reach than retail broadband providers going it alone.

This holds incredible potential as it may be possible to finally break the cycle of rural Americans being left behind as advancements in Internet network technology happens exclusively in urban markets. Promoting wholesale networks where anchor institutions, retail broadband providers, local governments, and other potential customers can pool their resources along with the appropriate subsidies from the federal government can be the means of extending fiber optic cable to rural towns at *lower costs* than directly subsidizing individual ISPs. Given the capacity of fiber, multiple shared uses is feasible while retaining high-speeds. Lastly, given what we know about fiber optic communications today and its upward potential, such long term investments will likely remain relevant and useful for decades.

Fiber to the Home, Once Built, is Substantially Cheaper for ISPs to Upgrade with Advances in Electronics to a Degree that Vastly Outpaces Legacy Networks

Historically the tearing up of the roads and other infrastructural challenges for deploying a network constituted close to 80 percent of the costs for an ISP.[18] But advances in processing technology today mean that fiber can be upgraded cheaply and quickly even after it has been built to the home. This is because the exceedingly high transmission potential of fiber optics to pass information requires only the equipment that transmits data to be switched out—no need for new civil works (a key source of costs for deployment).[19] Look no further than the most recent advances in time and wavelength division multiplexed passive optical network (TWDM-PON) technology[20] and the real world implications for an existing FTTH build in Chattanooga, TN, which is now the world's fastest retail broadband ISP.

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[17] Ilsa Godlovitch & Tseveen Gantumur, *The Role of Wholesale Only Models in Future Networks and Applications*, WIK-CONSULT, Mar. 23, 2018, available at https://www.stokab.se/Documents/Nyheter%20bilagor/The%20role%20of%20wholesale%20only_WIK.pdf.

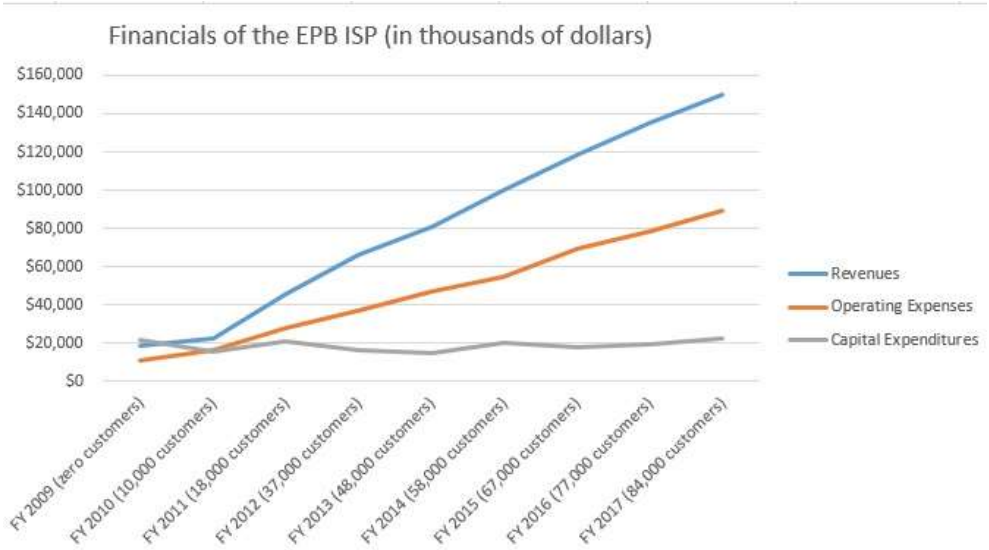
[18] EUROPEAN COMMISSION, *Analysys Mason: Support for the Preparation of an Impact Assessment to Accompany an EU Initiative on Reducing the Costs of High-Speed Broadband Infrastructure Deployment* at 36, http://ec.europa.eu/digital-agenda/en/news/support-preparation-impact-assessment-accompany-eu-initiative-reducing-costs-high-speed; *See also* INTERNATIONAL TELECOMMUNICATION UNION, *Cost Analysis for Fiber to the Home*, http://www.ictregulationtoolkit.org/en/toolkit/notes/PracticeNote/2974.

[19] "Frequently Asked Questions on Fiber Reliability," Corning, April 2016, https://www.corning.com/media/worldwide/coc/documents/Fiber/RC-%20White%20Papers/WP5082%203-31-2016.pdf.

[20] Ron Heron, *TWDM-PON: Taking Fiber to New Wavelengths*, NOKIA, Apr. 1, 2014, *available at* http://origin-prod-blog.nokia.com/en_int/twdm-pon-taking-fiber-new-wavelengths.

At its launch, EPB Fiber Optics, a community broadband company run by the local government, was the first ISP in the country to offer symmetrical gigabit service followed by Google Fiber.[21] In 2015, companies such as Alcatel Lucent added capacity to currently existing fiber optic lines by essentially increasing the number of transmissions that could pass through a fiber strand several times over previously existing fiber optic network technology.

When EPB decided to switch out its electronics in 2015 to upgrade from a gigabit network to a 10 gigabit network[22], the costs to the ISP were so miniscule they are virtually invisible in their financial reports' capital expenditures.



Source: EPB Financial reports from 2009 to 2017[23]

This same low-cost high-return bandwidth upgrade is available to other currently existing FTTH deployments ensuring that even older fiber optic builds can leapfrog from 100 mbps to 1 gigabit and beyond without incurring additional construction costs. However, only an exceedingly small number of Americans have access to this type of infrastructure, leaving a majority of U.S. Internet users stuck with broadband networks that will not meet future capacity challenges.

The Stagnation in Fiber to the Home Deployment Will Mean the United States Will Be Unable to Utilize Future Advances in Internet Services and Applications

It is cheaper to upgrade and stay ahead of the growth of Internet usage with FTTH, yet no major ISP has announced an intention to upgrade to the clearly superior network infrastructure. As online services and applications become more dependent on high-speed connections, more Americans will be unable to utilize those services due to their inferior connection speeds. Being unable to make use of the latest advancements in Internet technologies means an impending

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[21] Christopher Mitchell, *Broadband at the Speed of Light: How Three Communities Build Next-Generation Networks* at 37 (Apr. 2012), Institute for Local Self-Reliance, available at http://www.ilsr.org/broadband-speed-light

[22] Lightwave Staff, *EPB Brings 10-GBPS FTTH to Chattanooga*, LIGHTWAVE, *available at* https://www.lightwaveonline.com/articles/2015/10/epb-brings-10-gbps-ftth-to-chattanooga.html.

[23] ELECTRIC POWER BOARD, Leadership and Annual Reports, *available at* https://epb.com/about-epb/leadership-annual-reports.

national crisis in economic prosperity lies over the horizon as next generation application and services will not simply wait for the US market to catch up to the world. Reliance on a local cable monopoly for rapidly increasing capacity needs places a real danger to American innovation and the FCC should actively explore ways that would pressure the industry to deploy FTTH.