HOMES WITH TAILS

WHAT IF YOU COULD OWN YOUR INTERNET CONNECTION?

Derek Slater and Tim Wu[†]

America's communications infrastructure is stuck at a copper wall. For the vast majority of homes, copper wires remain the principal means of receiving broadband Internet.[1] The deployment of fiber optic connections to the home would enable exponentially faster broadband connections,[2] and commentators view upgrading to a more robust network infrastructure as essential to America's economic growth.[3] However, the costs of such an upgrade are daunting

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1 ROBERT D. ATKINSON, ET AL., INFO. TECH & INNOVATION FOUND., EXPLAINING INTERNATIONAL BROADBAND LEADERSHIP 7 (2008) ("The standard broadband technologies in most areas are digital subscriber line (DSL) technologies and cable modems," which both rely on copper technologies); OECD Broadband Statistics, Percentage of Fiber Connections in Total Broadband Among Countries Reporting Fibre Subscribers, Dec. 2009, *available at* http://www.oecd.org/dataoecd/21/58/39574845.xls (estimating that only four percent of US broadband subscribers are served by fiber to the home).

2 *See* Comm. For Info., Computer, & Commc'n, OECD, DEVELOPMENTS IN FIBRE TECHNOLOGIES AND INVESTMENT 47–48 (2008).

3 *See generally, e.g.*, STEPHEN EZELL, ROBERT ATKINSON, DANIEL CASTRO & GEORGE

for private sector companies and even for governments.[4] These facts add up to a public policy challenge.

In this paper, we propose and describe a new way to encourage broadband deployment. Most proposals have focused on deployment as a problem for *firms* and for *government*.[5] Firms that provide broadband service question how a company can justify investments in a fiber infrastructure without a "killer app" that provides a new and proven revenue source different from what is available from existing copper wires. Governments question how they might build and operate their own networks, convince or pay existing carriers to do so, or encourage new market entrants to arrive and save the day.

We believe an innovative model holds unrealized promise: household investments in fiber. Consumers may one day purchase and own fiber connections that run from their homes. With their own fiber connections, they would be able to connect to a number of service providers, including today's Internet, television, and telephone services, as well as ultra-bandwidth intensive services of the future. Consumers would have the opportunity not only to get a fast broadband connection, but could also benefit from greater competition and lower prices in the retail service market.

We call this property model "Homes with Tails," for the fiber would form part of the property right in the home. The key facets of our approach are:

- A "condominium" model for fiber ownership, in which individual strands of fiber are sold to consumers, while maintenance and other collective needs are managed jointly;
- Having private firms and municipalities consider selling fiber connections based on this model; and
- Government consideration of implementing various mechanisms to support consumer purchases, including a tax credit to homeowners or renters who purchase a broadband connection, and/or financial incentives for firms to sell fiber strands to consumers.

OU , THE NEED FOR SPEED: THE IMPORTANCE OF NEXT-GENERATION BROADBAND NETWORKS (2009) *available at* http://www.itif.org/files/2009-needforspeed.pdf; ROBERT CRANDALL, WILLIAM LEHR, & ROBERT LITAN, THE EFFECT OF BROADBAND DEPLOYMENT ON OUTPUT AND EMPLOYMENT: A CROSS-SECTIONAL ANALYSIS OF U.S. DATA (2007), *available at* http://www.brookings.edu/~/media/Files/rc/papers/2007/06labor_crandall/06labor_crandall.pdf; JOHN WINDHAUSEN, JR., A BLUEPRINT FOR BIG BROADBAND (2008), *available at* http://net.educause.edu/ir/library/pdf/EPO0801.pdf).

[4] *See, e.g.*, Saul Hansell, *A Smart Bet or a Big Mistake?*, N.Y. TIMES, Aug. 19, 2008, at C1 (discussing the costs of fiber to the home rollout); FED. COMMC'NS COMM'N, BROADBAND TASK FORCE STATUS REPORT OF SEPT. 29, 2009 45, 52 [hereinafter BROADBAND STATUS REPORT], *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-293742A1.pdf (estimating a $350 billion cost of universal service with fiber-to-the-home).

[5] *See, e.g.*, Robert D. Atkinson, *Framing a National Broadband Policy*, 16 COMMLAW CONSPECTUS 145, 151–53 (2007) (noting that both private sector companies and the government should play a role in broadband deployment).

Given the current dominance of service providers owning the broadband connection to the home, the idea of consumer-owned fiber may seem far-fetched. However, the concept of ownership for many items that consumers buy today would have seemed just as unusual not long ago. Until the development of the personal computer in the late 1970s, only large companies owned computers.[6] For decades, telephones were available only for lease, not for purchase.[7] Home fiber could be the next technology that moves into the realm of consumer property.

That said, the goal of this paper is rather limited: to outline what consumer-owned fiber might look like and suggest why it is worth investigating further.[8] We do not suggest that this model is the panacea for broadband policy challenges; rather, it might serve as part of a broader solution.[9] Furthermore, there are many empirical questions and obstacles to a successful implementation of consumer-owned fiber that cannot be fully evaluated at this time. In particular, no market for consumer purchase of fiber currently exists, and a collective action problem exists in deploying a network of this sort. The only way to truly test this model's feasibility is to attempt to implement it. Below, we describe one trial that is being attempted in Ottawa, Canada, and more experiments of this kind would provide important insights.

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6 *See infra* notes 43–45 and accompanying text.

7 *See infra* notes 38–42 and accompanying text.

8 We also note that other writers and scholars have proposed similar ideas. *See, e.g.*, Bill St. Arnaud, An Alternative Business Strategy for FTTh (last revised Aug. 27, 2007), *available at* http://www.slideshare.net/bstarn/fiber-to-the-home-business-model-presentation; David Gabel & Milton Mueller, *Household Financing of the First 100 Feet?*, *in* THE FIRST HUNDRED FEET 11, 11–13 (Deborah Hurley & James H. Keller eds. 1999); Eli Noam, *Make the User the Gatekeeper*, FINANCIAL TIMES, Feb. 11, 2008, http://www.ft.com/cms/s/0/f9b75e64-d8a2-11dc-8b22-0000779fd2ac.html; Lawrence Lessig, *Fiber to the People*, WIRED, Dec. 2003, at 10; Robert X. Cringely, *If We Build it They Will Come: It's Time to Own Our Own Last Mile*, PBS.ORG, Jun. 29, 2006, http://www.pbs.org/cringely/pulpit/2006/pulpit_20060629_000351.html; Posting of Brad Templeton, *The Glass Roots Movement*, to Brad Ideas, http://ideas.4brad.com/glass-roots-movement (Apr. 6, 2008, 17:07).

9 In addition, we have chosen only to focus on the deployment of last-mile fiber optic cable to the home. The reason is that deploying fiber all the way to a customer's premise is understood as eventually necessary to enable substantial advances in broadband speed, although there is debate about how soon such an upgrade is needed. *See* BROADBAND STATUS REPORT, *supra* note 4, at 38 ("End-to-end fiber networks offer nearly unlimited scalability and performance. FTTP is necessary to compete with the fastest national broadband infrastructures . . . ."); BERKMAN CENTER FOR INTERNET & SOCIETY, NEXT GENERATION CONNECTIVITY: A REVIEW OF BROADBAND INTERNET TRANSITIONS AND POLICY FROM AROUND THE WORLD 18 (Oct. 2009) [hereinafter BERKMAN CENTER REPORT], *available at* http://www.fcc.gov/stage/pdf/Berkman_Center_Broadband_Study_13Oct09.pdf (noting that other network architectures are "thought to be way stations on the way to a fully fiber optic infrastructure."). The model might also be applicable to proposals for a wireless last-mile, though in such models the price of deployment of the last mile technology is not usually the main challenge.

In the end, the intuition behind this paper is as old as property theory: that people will spend more on and value more that which they own.

I. BACKGROUND

A. The Intuition

At a speech in February 2006, James Crowe, the Chief Executive Officer of Level 3 Communications, presented a puzzle: why does Moore's Law seem not to work with bandwidth?[10] Moore's Law holds that the capacity of digital devices tends to increase exponentially, doubling about every two years.[11] Since 1965, Moore's Law has remained true. Processor speeds, as well as other digital indicators like hard drive storage, have grown exponentially, Crowe said, so why has the average speed of Internet connections lagged behind?[12]

Crowe's question is extremely interesting. On the one hand, his point should not be exaggerated: mean consumer bandwidth has increased over the last thirty years. The 300 bits per second modems of the early 1980s increased to fifty-six Kb/s of the 1990s,[13] and today, the average broadband speed in the United States is around two to five Mb/s.[14] But since the turn of the century, speed

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[10] James Crowe, *Regulation and Free Markets Redux: Additional Insights on Regulating the Telecommunications Industry in the New Economy,* 4 J. ON TELECOMM. & HIGH TE CH. L. 487, 488 (2007) ("I find it fascinating that until relatively recently, the price performance improvements of . . . processing and storing information . . . have been nothing short of magical. In comparison, the price performance improvements of communications have been relatively static.").

[11] In 1965, Intel co-founder Gordon Moore made a prediction, commonly referred to as Moore's Law, "that the number of transistors on a chip [would] double about every two years." Intel, Moore's Law, http://www.intel.com/technology/mooreslaw (last visited Oct. 27, 2009). *See also* HARRY NEWTON, NEWTON'S TELECOM DICTIONARY 734 (25th ed. 2009).

[12] Generally, as Tim Lee pointed out to us in an e-mail, there is also an interesting difference between the smooth climb in processor speeds, and the jumps that characterize increases in bandwidth. *See* E-Mail from Tim Lee (on file with the authors). There is reason to think that, were much of the public equipped with fiber to the home, we would begin to see Moore's Law–like speed increases premised on the dropping prices of lasers. Technologies of data transmission have improved very quickly. For example, the price per port of gigabit over fiber has dropped in recent years. *See, e.g.*, Brian Robinson, *Speedy Price Drop*, FED. COMPUTER WK., Jul 19, 2004, *available at* http://fcw.com/articles/2004/07/19/speedy-price-drop.aspx; Crowe, *supra* note 10, at 491 ("Optical technology may be the fastest improving technology in industrial history, doubling in price performance every nine to twelve months at the component level.").

[13] Daniel Doczy, *Connecting to the Network, in* DIGITAL SUBSCRIBER LINE 2001 COMPREHENSIVE REPORT 170 (International Engineering Consortium 2001).

[14] Estimates vary in determining average broadband speed. *See* AKAMAI, THE STATE OF THE INTERNET REPORT 38 (June 2009), *available at* http://www.akamai.com/stateoftheinternet/ (estimating 4.2 Mb/s); BERKMAN CENTER REPORT, *supra* note 9, at 47–58; ATKINSON ET AL., *supra* note 1, at 6,

increases have been relatively minor, and there are limits to how much more capacity can be wrenched from existing copper infrastructure, whether in the telephone lines or the coaxial wires used by the cable television industry.[15]

Our intuition is that the pattern of bandwidth growth may be related to how investment in the broadband industry is structured. For example, in the computer processor industry, processors are bundled with computers, and are sold directly to consumers and businesses. Both businesses and individuals have the means and the incentives to buy faster computers over time. Consequently, investments are decentralized across the entire world of computer users. Consumers and businesses spend thousands of dollars every few years to buy new computers, which represent capital investments in the processor, monitor, and storage industries.[16] Said differently, these industries all benefit from investments encouraged by the personal property system.

The computer processor industry also benefits from a diversity of buyers. The market for processor users includes both ordinary consumers and early adopters that have special demands, like scientists or graphic designers. Having a diversity of buyers allows the capital investments made by processor companies to be recouped more consistently. As researcher Tim Lee has said, "[v]irtually every cutting-edge technology is taken up by a small number of early adopters (who pay high prices for the privilege of being the first with a new technology) before it spreads to the general public, and the same model is likely to apply to customer-owned fiber."[17]

In the broadband industry, investments depend not on millions of consum-

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http://www.itif.org/files/ExplainingBBLeadership.pdf.

[15] Telephone networks could be upgraded to VDSL, allowing the possibility of speeds of fifty Mb/s downstream and thirty Mb/s upstream, but this requires companies to build out fiber much closer to consumers and thus effectively shorten the local copper loop. Cable networks are looking to upgrade their networks to a new standard called DOCSIS 3.0, which promises greater bandwidth, with current possibilities in excess of 160 Mb/s downstream. However, this bandwidth will be shared among many customers, and is greatly limited in the upstream direction. In contrast, fiber to the home would make possible exponentially greater speeds in both directions. *See* ORGANIZATION FOR ECONOMIC CO-OPERATION & DEVELOPMENT, DEVELOPMENTS IN FIBRE TECHNOLOGIES AND INVESTMENT 4–5 (2008), http://www.oecd.org/dataoecd/49/8/40390735.pdf; *see* Henrik Almeida, Ericsson, VSDL: Taking the Wire to the Limit, http://www.ericsson.com/ericsson/corpinfo/publications/review/technology_update/archive/2009/issue_2/articles/vsdl2.shtml (last visited Oct. 29, 2009).

[16] *See, e.g.*, CONSUMER ELECTRONICS ASSOCIATION, INNOVATION: US ECONOMIC CONTRIBUTION OF CONSUMER ELECTRONICS 2–5 (2008), *available at* http://www.ce.org/PDF/CEA_Final_Report_20080401_Lo-Res.pdf (estimating the US consumer computer manufacturing sectors); Gerald V. Post, *How Often Should a Firm Buy New PCs?*, 42 COMMS. ACM, May 1999, at 17.

[17] Posting of Timothy B. Lee, *Does Your House Need a Tail?*, to Freedom to Tinker, http://www.freedom-to-tinker.com/blog/tblee/does-your-house-need-tail (Nov. 25, 2008, 10:22 EST).

ers, but on a handful of companies. These providers make the decision on whether or not to commit significant financial resources to upgrade their network infrastructure. It is a centralized investment model. Incentives for providers to deploy new and faster connections have led to a fundamentally different pattern of investment—one that focuses on maximizing returns on existing infrastructure.[18]

Generally speaking, the incentives for significant private infrastructure investments are relatively weak. Telephone and cable companies face fiscal quarter-to-quarter pressure to deliver high returns on any investment. Yet the required capital to deploy fiber to the home is massive, and such an investment takes a long time to recoup.[19] Given customers' willingness to pay for its services, commentators have estimated that profitability in fiber rollout depends on reaching at least a thirty-five to forty percent subscriber take-up for bundled "triple play" services.[20] Verizon's data regarding its FiOS fiber to the home ("FTTH") deployment are instructive of the time required before an investment can be recouped. Verizon began FiOS deployment in 2004 and expected to spend around twenty-three billion dollars to reach eighteen million homes, covering fifty percent of its territory, principally in urban or suburban areas.[21]

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[18] *See* Hansell, *supra* note 4 (noting that AT&T's Chief Technology Officer, John Donovan, "said the company might string fiber optic cables to its customers' homes in the future . . . [b]ut he argues that it was a smarter choice to try to get as much life out of the copper wire as possible . . . ." Donovan explained, "The ideal way to deploy technology is on the last day as fast as possible . . . .").

[19] *See* Hansell, *supra* note 4; COLUMBIA TELECOMM. CORP., FIBER OPTICS FOR GOVERNMENT AND PUBLIC BROADBAND: A FEASIBILITY STUDY 3, 4 (2007), *available at* http://www.sfgov.org/site/uploadedfiles/dtis/tech_connect/SFFiberFeasibility.pdf [hereinafter SAN FRANCISCO FIBER STUDY] (stating that it would likely take the city of San Francisco approximately nine to twenty-two years to recoup an investment in a city-wide fiber network, depending on the fiber deployment model).

[20] ANUPAM BANERJEE & MARVIN SIRBU, TOWARDS TECHNOLOGICALLY AND COMPETITIVELY NEUTRAL FIBER TO THE HOME (FTTH) INFRASTRUCTURE 23 (2005), http://andrew.cmu.edu/user/sirbu/pubs/Banerjee_Sirbu.pdf (assuming ARPU per month to be $130, the paper estimates that thirty-five to forty percent penetration is necessary); *see also* FTTH COUNCIL, MUNICIPAL FIBER TO THE HOME DEPLOYMENTS: NEXT GENERATION BROADBAND AND A MUNICIPAL UTILITY 3 (2008), http://www.ftthcouncil.org/sites/default/files/Understanding%20the%20Benefits%20of%20Municipal%20Broadband.pdf [hereinafter MUNICIPAL FIBER TO THE HOME] (noting that a "typical FTTH business plan usually requir[es] a 30-40 percent take rate to 'break even' with payback periods.").

[21] Verizon, Verizon FiOS Product Sheet, http://newscenter.verizon.com/kit/nxtcomm/Product-sheet-FiOS-1Q07.pdf; *Verizon FiOS Profitable in 4 Years*, TVOVER.NET, Sept. 27, 2006, http://www.tvover.net/2006/09/27/Verizon+FiOS+Profitable+In+4+Years.aspx. In May 2009, Verizon announced that it was selling off its legacy network in rural areas to Frontier. Amol Sharma, *Verizon Sells Phone Lines In 14 States to Frontier*, WALL ST. J., May 14, 2009, at B1.

Verizon expected to generate positive operating income by 2009[22] with close to thirty-five percent take-up rates on Internet service and a twenty to twenty-five percent television take-up rate (while retaining a substantial portion of its existing telephony customers).[23] By June 30, 2009, their market penetration was twenty-eight and one-half percent for Internet and twenty-four and one-half percent for television.[24] While some believe that Verizon's deployment strategy will give it a strong advantage in the broadband market, others remain skeptical of FiOS' profitability even at a forty percent take-up rate.[25]

In addition, carriers have mixed incentives because new deployments can endanger existing revenue streams. First, deploying a FTTH network may undermines a provider's ability to continue to reap profits from its existing last-mile network. Second, applications and content offered over the Internet may compete with a provider's traditional revenue sources. For instance, faster access to online video services like Hulu can threaten the market for traditional television service.[26]

This is not to say that broadband providers like Verizon, AT&T, or Comcast have no reason to invest in broadband. Considerable network investments have been made, especially in the case of Verizon.[27] Nevertheless, the structural reasons above suggest that there will be less private sector investment in broadband connections than what is necessary to serve the national interest.[28]

To return to the difference between bandwidth and processor speeds: one rarely hears the question, "How can we encourage Intel to deploy faster proc-

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[22] Verizon FiOS Product Sheet, *supra* note 21.

[23] *Id*.; Verizon Communications Inc., FiOS Briefing Session 47, Sept. 27, 2006, http://investor.verizon.com/news/20060927/20060927.pdf. *See also* Posting of Saul Hansell, *A Bear Speaks: Why Verizon's Pricey FiOS Bet Won't Pay Off*, to N.Y. TIMES BITS BLOG, http://bits.blogs.nytimes.com/2008/08/19/a-bear-speaks-why-verizons-pricey-fios-bet-wont-pay-off/ (Aug. 19, 2008, 08:59 EST).

[24] Verizon, FiOS Fact Sheet, http://newscenter.verizon.com/kit/fios-symmetrical-internet-service/all-about-fios.html (last visited Nov. 9, 2009).

[25] *See* Arshad Mohammed, *Verizon Lays It on the Line*, WASH. POST, Feb. 1, 2006, at D1; Hansell, *supra* note 4; Hansell, *supra* note 23.

[26] Todd Spangler, *Breaking Free: Lured by Online Video, Digital Broadcasts, More Cable TV Customers are Cutting Their Service*, MULTICHANNEL NEWS, Nov. 1, 2008, http://www.multichannel.com/article/85964-Cover_Story_Breaking_Free.php.

[27] *See* TVOVER.NET, *supra* note 21 (noting that Verizon will invest nearly twenty-three billion dollars in its FiOS network). Comcast and AT&T have also made investments, though significantly less than Verizon. *See* Vishesh Kumar, *Is Faster Access to the Internet Needed?*, WALL ST. J., Apr. 10, 2008, at B5 (stating that Comcast's DOCSIS 3.0 investment is estimated to cost less than Verizon's investment); Hansell, *supra* note 23 (comparing the strategies of AT&T and Verizon).

[28] In addition, because broadband has significant positive externalities, providers may not have sufficient incentives to deploy broadband in a way that maximizes total social welfare. *See* Atkinson, *supra* note 5, at 153–165; Richard S. Whitt, *Evolving Broadband Policy: Taking Adaptive Stances to Foster Optimal Internet Platforms*, 17 COMMLAW CONSPECTUS 417, 457–461 (2009).

essors?" The reason is that Intel does not need to invest in the deployment of its processors. It simply makes them available for sale. In effect, millions of consumers–a crowd, as opposed to a small group of companies–make the decisions to invest in the faster processors. This is the difference between a decentralized, property-based investment model and a more centralized paradigm. The deeper question is whether such a decentralized investment model is actually possible for broadband.

B. Shifting Boundaries of Consumer, Cooperative, and Centralized Control

Today, the operating assumption is that broadband networks must be centrally owned and deployed. However, the division between consumer property, community property, and what private firms provide as a service has a history of evolving over time.

Consider the telephone and telephone lines. In the industry's early history, homeowners and communities sometimes owned telephones and telephone lines.[29] Unserved communities set up phone systems using their own wires.[30] As Milton Mueller and David Gabel write, "[i]nstead of depending on regional or national markets . . . local independent telephone companies relied almost exclusively on local capital and local labor."[31] To get service, consumers were often required to provide their own telephone lines running from their house to the main line, and assist with the physical work of stringing lines back to the switch.[32] By relying on homeowners and farmers to provide much of the infrastructure themselves, the early rural telephone networks could survive financially with much less capital.

That model ended with the ascendancy of the Bell system in the 1910s and 1920s.[33] Thereafter, and for most of the twentieth century, the wires and even the physical telephone could not be owned, but rather were available for lease.[34] The Bell lease model changed again in the 1970s after the Federal Communications Commission's *Carterfone* decision[35] and the *Computer In-*

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29 Gabel & Mueller, *supra* note 8, at 13.

30 *See id*.

31 *Id*.

32 *Id*.

33 *See* Gerald W. Brock, *Historical Overview*, *in* HANDBOOK OF TELECOMMUNICATIONS ECONOMICS Vol. 1 44, 51 (2002).

34 Ashley Andeen and John Leslie King, *Addressing and the Future of Communications Competition: Lessons from Telephony and the Internet*, *in* COORDINATING THE INTERNET 218 (Brian Kahin & James H. Keller, eds., 2000). *See generally* GERALD W. BROCK, THE TELECOMMUNICATIONS INDUSTRY: THE DYNAMICS OF MARKET STRUCTURE (1981) (providing a history of AT&T and the telecommunications history).

35 *In re* Use of the Carterfone Device in Message Toll Telephone Service, Thomas F. Carter and Carter Electronics Corp., Dallas, Tex. (Complainants) v. American Telephone

quiries orders,[36] which effectively propertized the telephone and most other network attachments.[37] By the 1980s, the telephone and in-home wiring were, once again, something consumers could purchase and own.[38]

In the history of electrification we see a similar story. Private firms were often unwilling to wire rural areas, believing that the return on investment was insufficient.[39] To provide service in these remote areas, community-owned wires and electric utilities developed.[40] In a "utility cooperative," or rural electric co-op model, the members of a rural community create and fund an organization that then runs wires to homes and either purchases or generates electricity for the community.[41] The use of this model exploded in the 1930s, and today utility cooperatives continue to serve more than forty million Americans.[42]

Finally, early computers were themselves once a form of shared property, used by numerous people and sometimes multiple firms at once, in the mainframe and supercomputer models.[43] As Nicholas Carr wrote in *The Big Switch: Rewiring the World, from Edison to Google*, "[d]uring the mainframe era . . . computers were institutional machines . . . [and] the rent on a typical IBM computer was about $30,000 a month in the mid-1960s . . . . That meant that individual employees almost never had direct access to a computer."[44] The rea-

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and Telegraph Co., Associated Bell System Companies, Southwestern Bell Telephone Co., and General Telephone Co. of the Southwest (Defendants), *Decision*, 13 F.C.C. 2d 420 (June 26, 1968).

36 *In re* Regulatory and Policy Problems Presented by the Interdependence of Computer and Communication Services and Facilities, *Notice of Inquiry*, 7 F.C.C. 2d 11 (Nov. 9, 1966); *In re* Amendment of Section 64.702 of the Commission's Rules and Regulations (Second Computer Inquiry), *Final Decision*, 77 F.C.C. 2d 384 (Apr. 7, 1980); *In re* Amendment of Sections 64.702 of the Commission's Rules and Regulations (Third Computer Inquiry); and Policy and Rules Concerning Rates for Competitive Common Carrier Services and Facilities Authorization Thereof; Communications Protocols under Section 64.702 of the Commission's Rules and Regulations, *Report and Order*, 104 F.C.C. 2d 958 (May 15, 1986).

37 See Glenn O. Robinson, *The Titanic Remembered: AT&T and the Changing World of Telecommunications,* 5 YALE J. REG. 517, 521–23 (1988) (discussing the evolution of network attachment rights).

38 *See supra* notes 35–37 and accompanying text.

39 LAURENCE J. MALONE, COMMONALITIES: THE R.E.A. AND HIGH-SPEED RURAL INTERNET ACCESS 3–6 (2001), *available at* http://arxiv.org/ftp/cs/papers/0109/0109064.pdf.

40 *Id.*

41 *Id*.

42 National Rural Electric Cooperative Association, About Co-Ops, http://nreca.org/AboutUs/Co-op101.htm (last visited Oct. 28, 2009); *see also* MALONE, *supra* note 39, at 5.

43 ROY A. ALLAN, A HISTORY OF THE PERSONAL COMPUTER: THE PEOPLE AND THE TECHNOLOGY 2/3 (2001).

44 NICHOLAS CARR, THE BIG SWITCH*:* REWIRING THE WORLD, FROM EDISON TO GOOGLE 52 (2008).

son that we think of computers as individual or personal property today is because of the idea of a "personal" computer, as pioneered by MITS, Apple, and others.[45] The personal computer was partly based on improved technology and cost efficiencies, but it was also premised on a rethinking of what a "computer" could be.

In sum, who "owns" a utility or a product is something that has changed over the years. There should be no reason to assume that fiber deployment will always be a question of waiting for the phone or cable company to build and lease it to consumers.

C. Current Approaches to Broadband Deployment

As Robert Atkinson writes, "[b]roadband has become a 'motherhood and apple pie' issue; no one is against more of it."[46] The problem, however, is how to get more aggregate bandwidth in the United States without wasting public money or destroying all private incentives to deploy it.

Different approaches to broadband deployment have been taken throughout the world,[47] which can be recognized in roughly three distinct approaches. The first approach, typified by South Korea and Japan, is to provide significant tax incentives and heavy public investment into the deployment of fiber, primarily by principal or national telecommunications firms such as Korea Telecom or NTT.[48] The second approach, found in many European nations, is a more mixed method, relying upon rules mandating competitor access to the facilities of the incumbent carriers and the hope that market entrants will stimulate demand for broadband.[49] In recent years, European policymakers have taken more interest in creating a separation between the businesses that own the copper or fiber and those that run the networks.[50]

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[45] Computer History Museum, Timeline of Computer History, http://www.computerhistory.org/timeline/?category=cmptr (last visited Nov. 13, 2009).

[46] Robert D. Atkinson, *Framing a National Broadband Policy*, 16 COMMLAW CONSPECTUS 146, 176 (2007).

[47] *See generally* BERKMAN CENTER REPORT, *supra* note 9; ATKINSON ET AL., *supra* note 1.

[48] *See* BERKMAN CENTER REPORT, *supra* note 9, at 191–205; ATKINSON ET AL., *supra* note 1, at Appendix C1 and D1.

[49] *See* BERKMAN CENTER REPORT, *supra* note 9, at 74–80, 89–106; ATKINSON ET AL., *supra* note 1, at 34–37.

[50] *See* Viviane Reding, Member, Eur. Comm'n Responsible for Info. Soc'y and Media, Better Regulation for a Single Market in Telecoms, Address at Plenary Meeting of the European Regulators Group (Oct. 11, 2007), *available at* http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/07/624&format=HTML&aged=1.

> [T]he instrument of functional separation should be added to the remedial tool box of national telecom regulators . . . . Functional separation means that inside a company . .

Finally, the third approach, as exemplified in the U.S. since the mid-1990s, has been to minimize government involvement,[51] leaving infrastructure deployment essentially to the private sector.

Each approach has its associated costs and benefits. The approach taken by Japan and South Korea have reportedly achieved the greatest speeds and market penetration, but there is a higher risk of government mismanagement and waste. The European approach has also generally achieved high broadband penetration rates, but mostly over existing copper connections.[52] Finally, the United States has more facility-level competition than most other nations, because of the existence of a well-developed cable industry.[53] The main problem with the hands-off approach in the U.S. is the prospect of underinvestment relative to what might be in the public interest. The result of this underinvestment is that the United States is no longer a world leader in broadband speeds or market penetration.[54]

The property rights approach suggested here is an alternative to all of these approaches and provides some unique advantages.

II. PROPERTY RIGHTS IN THE LAST MILE

What would customer ownership of a broadband connection look like in practice? We detail its key aspects below.

> . a clear line is drawn . . . between the access business and the services branch of the company, while non-discriminatory access is granted to service providers to the access network.

Id.

[51] *See* BERKMAN CENTER REPORT, *supra* note 9, at 82–83; ATKINSON ET AL., *supra* note 1, at 21–22; S. DEREK TURNER, DISMANTLING DIGITAL DEREGULATION 33–55 (2009), *available at* http://www.freepress.net/files/Dismantling_Digital_Deregulation.pdf.

[52] *See* BERKMAN CENTER REPORT, *supra* note 9, at 77–80; ATKINSON ET AL., *supra* note 1, at 6.

[53] Facility-level competition refers to service providers using their own network infrastructure to compete and deliver services, while "non-facilities-based competitors, by contrast, offer services over the networks of others." John Blevins, *A Fragile Foundation-The Role of "Intermodal" and "Facilities-Based" Competition in Communications Policy*, 60 ALA. L. REV. 241, 250 (2009). *See* ATKINSON ET AL., *supra* note 1, at 33–34 (discussing intermodal competition in the U.S. between telephone and cable companies).

[54] BERKMAN CENTER REPORT, *supra* note 9, at 10; ATKINSON ET AL., *supra* note 1, at 5–9. *But see* T. RANDOLPH BEARD, GEORGE S. FORD, & LAWRENCE J. SPIWAK, THE BROADBAND ADOPTION INDEX: IMPROVING MEASUREMENTS AND COMPARISONS OF BROADBAND DEPLOYMENT AND ADOPTION, PHOENIX CENTER POLICY PAPER NO. 36 (2009), http://www.phoenix-center.org/pcpp/PCPP36Final.pdf.

A. The Condominium Model for Fiber Ownership[55]

In our model, a fiber optic cable, as the home's "tail," would, in law, become part of the home as a form of fixture.[56] The consumer would own one or more strands of fiber, running from her home to a point of interconnection, known in telecom jargon as the Point of Presence ("PoP"), as shown below.[57] The owner would then be in a position to lease Internet, television, or telephone services, and pay for management of any physical problems that might arise with their fiber optic cable.

Significantly, a consumer would not run her own wholly separate fiber connection to the PoP. Such a connection would be costly and impractical. Instead, a trunk cable containing hundreds of individual strands of fiber, would be run to an entire neighborhood in order to serve the many individual homes within it.[58] The fiber/trunk architecture necessitates an ownership structure that is, at least in part, a mixture of individual and collective property.

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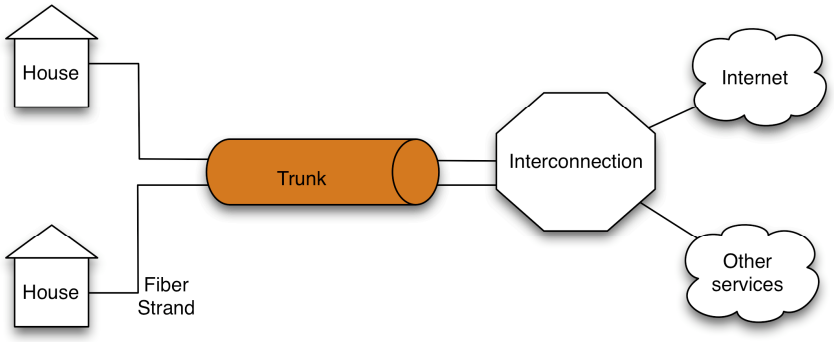
[55] We credit Bill St. Arnaud for suggesting this idea to us. *See* St. Arnaud, *supra* note 8 (proposing the development of the condominium fiber network).

[56] Some may think it is strange to have home owners owning a wire or fiber that leaves the boundaries of the property. But it is not unheard of for private property to extend to public places, such as automobiles and airplanes, which move from private to public areas regularly.

[57] Point of Presence is defined as "[a] physical place where a carrier has a presence for network access, a POP generally is in the form of a switch or router." HARRY NEWTON, NEWTON'S TELECOM DICTIONARY 870 (25th ed. 2009). The particular network topology that we propose is called "home run" or "point to point" fiber because the strands of fiber running from the PoP to the customer are dedicated only to that subscriber. Each subscriber can connect their fiber to a service provider of their own choosing. In addition, a home run topology allows for upgrades in bandwidth without having to change any equipment in the field and grants service providers maximal flexibility, as they can use the technology of their choice at the PoP to service their customers. *See* SAN FRANCISCO FIBER STUDY, *supra* note 19, at 128, 130–36, 153–54 (recommending and describing a "home run" topology); Banerjee & Sirbu, *supra* note 20, at 4–6, 22. In contrast, some topologies aggregate multiple customers' strands of fiber somewhere in the field, between the PoP and the customers. There are other models of customer ownership that could accommodate this topology, but we do not consider these further in this paper. *See supra* text accompanying note 9.

[58] From this trunk, groups of strands are split off to run down individual streets ("laterals"), and then individual strands serve specific homes ("drops"). *See* Bill St. Arnaud, FAQ About Customer Owned Dark Fiber, http://emperor.canarie.ca/MLISTS/news2000/0135.html (last visited Nov. 15, 2009).

Figure 1. Condominium Fiber Model



Our proposed ownership structure is a condominium model.[59] In real estate, condominiums are designed to allow densely packed homes to be individually owned while the building and grounds are shared.[60] Customer-owned fiber presents a similar class of problems, and may be addressed by a similar ownership structure.

According to Black's Law Dictionary, a condominium is: "A single real-estate unit in a multi-unit development in which a person has both separate ownership of a unit and a common interest, along with the development's other owners, in the common areas."[61] The unit owners share ownership of the hallways, elevators, heating ducts, and other common areas, and they pay recurring fees in order to finance maintenance of the building.[62] The common areas are managed through a separate legal entity, the community association, which consists of all the unit owners and is run by a board of directors.[63]

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[59] As suggested by the utility cooperatives discussed earlier, another model is the co-op model, but in this paper we focus on condominiums. *See supra* notes 39–42 and accompanying text.

[60] ROGER A. CUNNINGHAM ET AL., THE LAW OF PROPERTY 34, (2d ed. 1993). The first condominium law was Article 664 of the Code Napoleon of 1804. *Id*. at 34 n.26.

[61] BLACK'S LAW DICTIONARY 336 (9th ed. 2009).

[62] Richard J. Kane, *The Financing of Cooperatives and Condominiums: A Retrospective*, 73 ST. JOHN'S L. REV. 101, 105 (1999); CUNNINGHAM ET AL., *supra* note 60, at 34.

[63] *See, e.g.*, Center for Community Association Volunteers, An Introduction to Community Association Living 4, 24 (2006), *available at* http://www.caionline.org/info/readingroom/Publication%20Excerpt%20Library/community_association_living.pdf.

In a fiber-condo, each homeowner would own separate strands of fiber, but the trunk that runs through the neighborhood would be collectively owned. After the fiber is installed, the community would contract with a professional management company to maintain it. This company would then charge each homeowner any necessary maintenance fees, similar to condominium maintenance fees.

Condominiums depend on the investments of unit owners to fund the construction of the entire building.[64] Similarly, for last-mile fiber, building the trunk and related structures would ultimately be funded by the investment in the individual strands.

In the past, condominiums were seen as a relatively radical form of property ownership.[65] Today, owning a condo is a normal form of property ownership– the split between individual and collective ownership is taken for granted. Split ownership of fiber may become normal in a similar fashion.

B. Who Builds?

If consumers are the owners of their fiber strands, who would act as the fiber provider responsible for clearing rights of way, deployment, and maintenance? Various entities might build the network and then sell strands of fiber, including:

Carriers: The first possibility is carriers–existing or new wire information services providers, such as telephone and cable companies. Along with selling services, a provider could start "don't lease, buy" programs that allow customers to buy fiber strands.

Municipalities: Local governments might also decide to become fiber providers in this model. Over forty municipalities in the United States and many European cities are already actively deploying fiber to the home.[66] Some provide retail services, some are only wholesalers, and some mix the two models.[67] Selling fiber connections could provide a replacement for or supplement to these models.

For example, the UTOPIA FTTH network in Utah is moving toward a simi-

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64 *Cf.* Kane, *supra* note 62, at 125–126.

65 *Cf.* Kane, *supra* note 62, at 108; *see also* Robert H. Nelson, *The Private Neighborhood*, REG., Summer 2004, at 40 (noting that while in 1970, only "about one percent of all Americans belonged to private community associations . . . [b]y 2004, more than seventeen percent belonged to a homeowners or condominium association, or were part of a cooperative . . . .").

66 MUNICIPAL FIBER TO THE HOME, *supra* note 20, at 2; *see also* Carol Wilson, *FTTH with European Flair*, TELEPHONY ONLINE, Sept. 16, 2008, http://telephonyonline.com/fttp/news/telecom_ftth_european_flair/.

67 *See* Wilson, *supra* note 66.

lar business model, although not granting any actual property rights in the fiber optic cable to its consumers. Before UTOPIA runs fiber down a neighborhood's streets and offers wholesale access to service providers, a certain number of subscribers must commit to pay a "cooperative membership fee"–a lump sum investment separate from any monthly service charge.[68] In Brigham City, Utah, users can choose to pay $3,000 to have fiber rolled out to their home, or pay twenty-five dollars per month for twenty years.[69]

Fiber Construction Firms: Carriers and municipalities contract with specialized third-party construction firms in order to deploy fiber today. Businesses and universities also work with these construction companies to build their own networks.[70] These construction firms could deploy fiber to homes and sell off strands independently themselves, providing whatever limited maintenance might be necessary.

Real Estate Developers: Real estate developers could arrange for customer ownership of fiber by building connections into new homes before they are sold. Recent surveys suggest that fast fiber connections could be a significant selling point for home buyers.[71]

Customer ownership may be especially practical for "planned communities," housing communities set up along the same lines as a condominium complex. The Issaquah Highlands development in Issaquah, Washington provides an excellent example of this model. Issaquah Highlands bills itself as an "urban village" that aims to recreate the feeling of a small town.[72] The developer of Issaquah Highlands, Port Blakely is running fiber to every home there, as its Web site states:

> The Highlands Fiber Network utilizes its own fiber optic system to connect every home in Issaquah Highlands to the internet. Residents who use the service can access the internet through different price packages . . . . Since the inception of HFN the vi-

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[68] Grace Leong & Joe Pyrah, *The Case for UTOPIA and iProvo: Double Down or Cut Bait?*, DAILY HERALD (Provo, UT), Apr. 21, 2008, at A1.

[69] Nancy B. Fuller, *Moving Forward with Fiber Optics,* STANDARD-EXAMINER (Ogden, Utah), Nov. 8, 2009, *available at* http://www.standard.net/topics/business/2009/11/08/moving-forward-fiber-optics-brigham-city-approves-3000-voluntary-property; Geoff Daily, *UTOPIA Trailblazing New Opportunity for User-Owned Fiber*, Apps-Rising.com, Nov. 16, 2009, http://www.app-rising.com/2009/11/utopia_proving_new_option_for.html.

[70] For examples of fiber building companies, *see, e.g.*, Sunesys Corp., www.sunesys.com; Black & Veatch, www.bvtelecom.com; Internetworking Atlantic Inc., www.internetworking-atlantic.com; Société de Réseaux Dédiés Privés de Télécommunication Inc., http://www.srdptele.com/en/.

[71] *See* FTTH COUNCIL, FIBER-TO-THE-HOME COUNCIL / RVA LLC 2009 CONSUMER FTTH AND BROADBAND SURVEY 2 (2009), http://www.ftthcouncil.org/sites/default/files/2009Consumersurveykeyfindings%20FINAL.pdf [hereinafter CONSUMER FTTH AND BROADBAND SURVEY].

[72] City of Issaquah, Issaquah Highlands, http://www.ci.issaquah.wa.us/page.asp?navid=76 (last visited Oct. 31, 2009).

> sion has been for it to be owned by the community. Port Blakely agreed to build out the system and operate it until the initial construction and operating costs are repaid. After that point, the Highlands Council has the opportunity to acquire full ownership of HFN and Port Blakely would no longer be involved in the operation.[73]

Every homeowner pays a $250 hook-up fee and a monthly fee for Internet access.[74] The Isomedia firm was selected through a bidding process to be the exclusive Internet service provider ("ISP") over the Highlands Fiber Network.[75] While the homeowners cannot individually choose to connect their strands to other service providers, the community association has the option to open up bidding to new service providers in the future.[76]

C. Interconnection, and Who Provides Services?

The final piece of this model is the point of interconnection. If the customer owns the fiber, with whom can he or she connect? For ownership to make a major difference, consumers must be able to use their connection to access a multitude of differently priced services from a variety of service providers.

In an ideal scenario, customer-owned fiber would run from the home to an interconnection facility that is equally open to many service providers. Service providers would then be able to pay a fee to locate their networking equipment at the interconnection facility and offer Internet, television, voice, or other services in direct competition with each another.[77]

We call this sort of interconnection facility an Open PoP, and the idea is not particularly novel. For instance, Amsterdam's Citynet fiber network allows multiple service providers to install their own equipment in each PoP and provides non-discriminatory access to these facilities.[78] Herman Wagter, managing

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[73] Highlands Fiber Network, https://www.highlandsfibernetwork.com/customerservice.html (last visited Oct. 31, 2009).

[74] Highlands Fiber Network, Fiber internet Service, https://www.highlandsfibernetwork.com/internetservice.html (last visited Oct. 31, 2009).

[75] *Highlands Fiber Network Welcomes ISOMEDIA.COM as ISP Provider*, CONNECTIONS, Jun. 2004, at 1, *available at* http://www.issaquahhighlands.com/pdf/connect/jun2004.pdf.

[76] Telephone Interview with Robert Black, General Manager, Highlands Fiber Network (Aug. 6, 2008); *see also* Highlands Fiber Network, https://www.highlandsfibernetwork.com/customerservice.html (last visited Sept. 15, 2009).

[77] Banerjee & Sirbu, *supra* note 20, at 22; *see also* SAN FRANCISCO FIBER STUDY, *supra* note 19, at 141–50 (providing useful taxonomies of different types of open access). Here, we are imagining that different companies would be able to employ different data link layer technologies of their own choosing. Banerjee and Sirbu call this data link layer unbundling whereas the San Francisco Fiber Study refers to this as physical layer open access.

[78] *See* Gordon Cook, *Financing Amsterdam's Huge FTTH Build*, BROADBAND PROPERTIES, at 68–69 Sept. 2006; *available at* http://www.broadbandproperties.com/2006issues/sep06issues/cook_sep.pdf; Pauline Rigby, *Amsterdam's Citynet Scores a Home Run for Fibre*, FIBRESYSTEMS EUROPE, Dec. 2008–Jan. 2009, at 16, *available at* http://fibresystems.org/cws/article/magazine/37080.

director of Citynet, explained, "In the switch house [central office] or interconnection point . . . we provide for different racks for different operators, because on a line by line basis customers could sign up for different combinations of . . . offerings."[79]

We anticipate that an Open PoP could operate similarly in a customer-owned fiber model. When a customer chooses to sign up with a particular service provider, the provider would connect the customer's fiber strands to its own equipment at the PoP.[80] The service provider would also have to visit the customer's home to install networking equipment, just as Verizon must when it installs equipment for its FiOS service.[81]

The key benefit of the Open PoP in this model is that it lowers the barriers to entry for service providers and thus encourages competition in that market. Firms would be able to offer advanced Internet services, as well as new infor-

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[79] *See* Cook, *supra* note 78, at 69 (alteration in original); *see also* E-mail Interview with Herman Wagter, Managing Director of Citynet (Aug. 2008) (on file with authors).

[80] One can also envision a few variations. For instance, as in the Highlands Fiber Network, a community could contract with a single provider to provide service to everyone, and the community could collectively decide to switch providers at some point in the future. Another alternative would be for a community to contract with a single provider to "light the fiber," operate the network at the data link layer, and then provide "bitstream access" to third-parties, who would be able to provide Internet access and other services. Each individual consumer could then choose among these third-parties. This would make it even easier for independent service providers to enter the market, though it would in some ways limit how each provider could differentiate itself in the market.

Both of these models could accommodate a point-to-multipoint network topology in which strands of fiber are aggregated somewhere between the PoP and the end-users, which is typically accomplished with the use of passive optical network (PON) splitter technology. Another possibility is that, with advances in a technology called WDM-PON, each consumer could own their own wavelength of light rather than their own fiber strand, and they could then connect this wavelength to the service provider of their choice at the PoP. *See* Banerjee and Sirbu, *supra* note 20, at 21 (discussing a "wavelength per subscriber" model for fiber networks); *see* Meghan Fuller, *WDM-PON Gains Notice in the U.S.*, LIGHTWAVE, Jan. 31, 2006, http://www.lightwaveonline.com/about-us/lightwave-issue-archives/issue/wdm-pon-gains-notice-in-the-us-53426892.html.

[81] Dan Bricklin provides a good summary of a consumer's' description of how Verizon's FiOS is installed to the home. *See* Dan Bricklin, Installing Verizon's FiOS Fiber-Optic Internet Service to My House, http://www.bricklin.com/fiosinstall.htm (last visited Sept. 15, 2009) (discussing installation of the optical network terminal). In more technical terms, each service provider would be responsible for providing its own customer premise equipment ("CPE"), which receives the light from the fiber and turns it into electrical signals Alternatively, a given consumer-owned network could standardize around a given CPE, which would make switching providers considerably simpler. *See* FTTH COUNCIL, FIBER TO THE HOME: ADVANTAGES OF OPTICAL ACCESS 24 (2009) [hereinafter FTTH ADVANTAGES], *available at* http://www.salisburync.gov/ftth/fiber_advantages.pdf. For instance, in order to provide Internet service, the CPE would turn the light pulses into Ethernet signals, and then you would connect your computer to the Ethernet port on your CPE. This hardware function is also referred to as the optical network unit or optical Network Terminal.). FTTH ADVANTAGES, *supra* note 81, at 24.

mation services independent of the Internet. For example, your job may require you and your spouse to spend significant time apart every week. A provider of high-definition ("HD") telepresence[82] might sell you a service, independent of Internet connectivity, which allows you and your spouse to talk to and see each other in real time. As explored further below, this sort of novel application could provide a significant attraction for consumers.

III. COSTS AND BENEFITS OF THE MODEL

A. How Much Will it Cost Per Customer?

It is impossible to precisely enumerate how much fiber would cost for a given individual. However, three factors are the most important in any cost analysis: take-up, housing density, and whether fiber can be deployed aerially (for instance on telephone poles) or must be run underground.[83]

*Take-up***:** FTTH deployment faces high fixed initial costs.[84] For that reason the take-up rate can have a large impact on the per-customer cost. The cost of running a fiber trunk through a neighborhood is essentially the same regardless of how many people sign up to have individual strands run to their home. Put differently, once fiber has been run down your street and to your home, the marginal cost of running it past your neighbors' houses at the same time is relatively small. As such, the more people that agree to pay for fiber to run through a given neighborhood, the more the total cost of passing homes with fiber is spread around, and the lower the per-customer cost becomes.

Housing density: FTTH providers also find it cheaper to deploy in high density neighborhoods.[85] If homeowners are spread out over a greater geographical distance, the cost of running fiber down each street will be higher on a per-customer basis.

Aerial versus underground: Generally, aerial construction is significantly cheaper than digging up neighborhood streets and running fiber underground. For example, in 2007 the city of San Francisco commissioned a study of how much it would cost to connect every home in San Francisco with fiber, spanning the municipality's nine hundred miles of streets. The aerial construction

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[82] Alois Knoll, *Toward High-Definition Telepresence*, 16 PRESENCE i, i (2007) (defining telepresence as "technologies that allow human operators to feel (and act) as if they were present in a remote location . . . .").

[83] *See* Banerjee and Sirbu, *supra* note 20, at 25; *see also* SAN FRANCISCO FIBER STUDY, *supra* note 19, at 117–20 (estimating the aerial construction cost for a proposed San Francisco FTTH network at $41.7 million compared to constructing the network underground at an estimated cost of $231 million).

[84] *See* Hansell, *supra* note 4.

[85] *See* Banerjee and Sirbu, *supra* note 20, at 9.

cost estimate amounted to $41.9 million while the underground deployment cost estimate reached $327 million.[86]

A range of other factors can also impact the total and per-customer costs. For instance, some businesses, universities, and other institutions already purchase their own fiber connections, and other entities already cooperate to jointly buy and manage fiber.[87] These kinds of institutions might be willing to serve as "anchor tenants" in a deployment that also serves residential communities.[88] As such, the cost to homeowners may be lower in such neighborhoods.

Verizon's data is again instructive on this point. Verizon's average cost per-customer is estimated to be around $3,000 to $4,000, assuming a forty percent take-up rate.[89] At a twenty percent take-up rate, the cost is closer to $7,000.[90] These cost estimates are based on Verizon focusing mainly on dense metropolitan and suburban areas, with a mixture of aerial and buried fiber, and in close proximity to businesses.[91] Less dense suburban and rural areas would be significantly more expensive.[92]

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[86] SAN FRANCISCO FIBER STUDY, *supra* note 19, at 135 tbl.3.

[87] *See, e.g.*, Nestor Arellano, *Network Overhaul Works Many Wonders for Winnipeg School Division*, ITBUSINESS.CA, Jan. 30, 2008, *available at* http://www.itbusiness.ca/it/client/en/Home/News.asp?id=46947; Marguerite Reardon, *Dark Fiber: Businesses See the Light*, CNETNEWS.COM Feb. 1, 2005, http://news.cnet.com/Dark-fiber-Businesses-see-the-light/2100-1037_3-5557910.html; NYSRNet, Organizational Overview, http://www.nysernet.org/about/ (last visited Nov. 16, 2009) (describing the organization as "a consortium of visionary public and private New York State institutions [founded] to provide high-speed network connectivity to advance research and educational initiatives in the Empire State.").

[88] *See, e.g.*, Craig Aaron, *The Promise of Municipal Broadband*, THE PROGRESSIVE, Aug 2008, at 30 (discussing the city of Minneapolis acting as an anchor tenant for a completed municipal wireless network); CHARLES B. GOLDFARB & LENNARD G. KRUGER, CONGRESSIONAL RESEARCH SERVICE, INFRASTRUCTURE PROGRAMS: WHAT'S DIFFERENT ABOUT BROADBAND? 17 (2009) (describing a proposed Anchor Tenancy program to be run by the General Services Administration that "would assess whether the government-owned or –leased facilities in areas with little broadband infrastructure could act as anchor tenants . . . .").

[89] Mike Farrell, *Disconnect on Cost*, MULTICHANNEL NEWS, Jan. 19, 2008, http://www.multichannel.com/article/88938-Disconnect_on_Cost.php.

[90] *Id*.

[91] *Cf*. Verizon Communications, Inc., *Verizon FiOS Briefing Session*, Sept. 27, 2006, http://investor.verizon.com/news/20060927/20060927.pdf.

[92] *See* Banerjee and Sirbu, *supra* note 20, at 25 (comparing cost of urban, suburban, and rural areas); *cf*. SAN FRANCISCO FIBER STUDY, *supra* note 19, at 109–10. A "home run" fiber topology may be more expensive than a network like Verizon's, which uses less fiber and relies on passive optical network splitters to aggregate fiber in the field. However, the exact premium for a home run network is somewhat contested, as "[t]he difference in cost is limited; there is not a huge gap in costs," according to Benoit Felten. *See* Wilson, *supra* note 66. *See generally* KEYMILE, ETHERNET POINT-TO-POINT V. PON – A COMPARISON OF TWO OPTICAL ACCESS NETWORK TECHNOLOGIES AND THE DIFFERENT IMPACT ON OPERATIONS (2008), *available at* http://www.keymile.com/media/pl/internet/about_keymile/media_centre/white_paper/White

In all cases, it is important to recognize that individual neighborhoods may have radically different costs. The variations might average out over a large-scale deployment like Verizon's; in a small-scale deployment, however such variations can significantly change any cost estimates.

B. Utility of the Model for Fiber Providers and Service Providers

One of the chief challenges in fiber deployment today is the lack of a proven way to make additional money from selling services or, at the least, capital investors' lack of confidence in such revenue streams.[93] The prospect of gaining a forty percent take-up rate for fiber-based services is daunting, but is often necessary to justify a company's capital investment. However, if a fiber provider could get some level of consumer investment ahead of time, this would change the return on investment calculus.

This model would work as follows. Before running fiber into a neighborhood, carriers, municipalities, or other fiber providers might seek bandwidth-hungry early adopters to buy their own connection first. In this context, an early adopter is defined as a consumer who has special reasons to pay for an advanced technology now, as opposed to waiting for the technology to come down in price.[94] Just as consumers pay a premium to be the first person with a high-definition television or an Apple iPhone, consumers might pay a premium to be the first person with their own fiber connection. If ten percent commit to pay $3,000 for the connection, then the fiber provider only needs thirty percent take-up in services; which makes the service-based business case that much better. In an ideal neighborhood, where per-customer costs are lower than Verizon's averages, it may be possible to fund the entire roll-out with a relatively small number of customers.

Consumers could commit to pay in various ways. A consumer could pay with a lump sum upfront, or agree to an installment plan similar to a home mortgage. A carrier could try to get consumers to sign up for a multi-year retail service plan commitment in exchange for rights to own the fiber after the service period ends. The experiment in Ottawa, Canada discussed below exemplifies just one innovative way that the cost might be spread out over a five-year period—by bundling it with electrical bills.[95]

Paper_EPtP_vs_PON.pdf (comparing costs of point-to-point and point-to-multipoint networks).

93 *See supra* Part I.A.

94 Terry Maxon, *Firm Prize Early Adopters: They Spend Big on New Technology and They're a Good Gauge of What'll Sell*, DALLAS MORNING NEWS, Jan. 7, 2006, at 1D; *see generally* Geoffrey A. Moore, CROSSING THE CHASM: MARKETING AND SELLING HIGH-TECH PRODUCTS TO MAINSTREAM CUSTOMERS 12–13 (2002).

95 *See infra* Part IV.

For independent Internet service providers and competing providers of other information services, customer ownership of fiber would have an obvious advantage—ease of market entry. These providers would be able to enter the market quickly, since they would not have to incur the expense of deploying fiber themselves, and would only need to install equipment at the open PoP and the customer's home.

At the same time, one question that remains to be answered is whether lowering this barrier to entry is enough to attract multiple service providers into the market. Large incumbents, accustomed to owning their network, will likely resist giving up this control, and new entrants might still face significant barriers to competing against more established companies.

C. Will Consumers Bite?

Nothing in this model can work at all unless there are some reasons for consumers to want property rights in their fiber connections. Is there some "killer app" that might make consumers want a fiber connection?

While a challenge, we think the greatest short-term appeal will be to the "early adopters." In the long run, we believe consumers may be attracted to the possibility of greater competition and lower prices for retail services as well as access to services currently unavailable, like HD videoconferencing.

1. Early Adopters

In 2008, Australian phone company Telstra demoed much more advanced technology to allow its CTO to appear as a 3D-image and communicate with the audience in a room 460 miles away.[96] This task took an enormous amount of bandwidth, far beyond anything available to consumers today.[97] An interest in access to that kind of bandwidth—and the novel applications it enables—may motivate early adopters to buy fiber to the home.

When it comes to any plan to purchase connections, members of a neighborhood face a classic collective action problem. There are incentives to wait for others to deploy their own fiber first and become a '"free rider," by waiting for the inevitable lower prices that will be based in part on the earlier deployments.[98] However, in some cases, the demand of certain individuals—like early

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[96] Posting of Marguerite Reardon, *Beam Me Up, Telstra*, to CNET NEWS: NEWS BLOG, http://news.cnet.com/8301-10784_3-9955821-7.html (May 30, 2008, 09:24 EST).

[97] *Compare* Telepresence, IBC TV News, *available at* http://www.ibc-tvnews.com/cgi-bin-video_play.cgi?id=619 (describing the connection speed for the 3D telepresence video as 1.5 G/Bs) *with* AKAMAI, *supra* note 14 (describing the average broadband connection in the U.S. as 4.2 Mb/s).

[98] *See* MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION 33–34 (1965).

adopters—for a good or service may be strong enough to overcome the problem, particularly in many technological markets.

Early adopters, by definition, have an interest in fiber optics that is unusual compared to the general population. Some people may have special needs for bandwidth; for instance, a film editor who needs to transfer massive files between his home, his office, and other locations. Others may have a particularly strong distaste for relying on telephone or cable companies for their Internet connections, and want the freedom from incumbents that independent ownership might bring.

In addition, hobbyists who are interested in what they can do or invent with huge amounts of bandwidth are potential purchasers of their own fiber connections. These are the kind of people who bought computers in the 1970s. At that time, hobbyists spent thousands of dollars on computers that were initially capable of very little, and then formed computer clubs to find out what they collectively might build.[99]

Bill Gates, Steve Jobs, and many other future leaders of the computer industry came out of the computer clubs of the 1970s.[100] If buying fiber to the home becomes plausible, a similar wave of innovation could occur. In the future, clubs of ultra-high bandwidth fiber owners might work together to develop their own applications—imagine, for instance, a "Ten Gigabit club," a network catering exclusively to hobbyists with ten Gb/s or better connections.

Service providers and clubs of this sort might develop services like extremely high-speed video conferencing, full size high-definition movie streaming, hologram projection communication, or primitive versions of the holodecks imagined on the Star Trek television shows.[101] The freedom to innovate and create services not yet imagined at all is probably the greatest attraction for early adopters.

2. Regular Consumers

Demand for fiber connections already stretches beyond a small clique of early adopters. In a 2009 national survey, RVA Market Research and Consult-

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[99] ALLAN, *supra* note 43, at 4/9–12, 19/2 (listing a number of early computer clubs founded in the 1970s and describing a number of computer models and their costs—the Altair 8800 for $498, the IBM 5100 for $8,975 to $19,975, and the Sphere Hobbiest computer kit for $650).

[100] MARTIN CAMPBELL-KELLY & WILLIAM ASPRAY, COMPUTER: A HISTORY OF THE INFORMATION MACHINE 213–20 (2004).

[101] *See* Posting of John Markoff, *The Coming of the Holodeck*, to N.Y. TIMES BITS BLOG, http://bits.blogs.nytimes.com/2008/04/11/the-coming-of-the-holodeck (Apr. 11, 2008, 17:37 EST); W. Swartout et al., *Toward the Holodeck: Integrating Graphics, Sound, Character and Story* (2006), *available at* http://handle.dtic.mil/100.2/ADA459186.

ing found that sixty-nine percent of broadband users who cannot get "[v]ery high speed Internet from a direct fiber line" today view it as an important factor in purchasing a home in the future, and in fact, it would be "more important than other amenities such as green space/walking trails, 24 hour neighborhood patrol, a community pool, and a fitness center/club house."[102]

Would many of these consumers want to own a fiber connection? As discussed earlier, the things people buy are not always easy to predict and often change over time. While buying fiber might be expensive compared to the price of chewing gum, the cost of fiber ownership should be comparable to or cheaper than many other home improvements. Renovating a washroom, fixing a roof, or buying patio furniture also costs thousands or tens of thousands of dollars. Yet homeowners consistently improve and add value to their homes in many ways.

To approach the question systematically, we might ask why a consumer *ever* buys, as opposed to renting. One starting point is that consumers buy when rentals are simply not available. In areas that lack fiber networks today and where carriers are unlikely to serve, customers might want to take it upon themselves to acquire fiber connections. Just as farmers formed rural electric cooperatives, underserved homeowners in rural areas might want to pool resources to fund their own fiber network.

But in situations where a rental market does exist, why own items like skis, cars, or a home? For wealthy consumers, the price differential of purchasing a connection may be relatively trivial. It may just be a matter of preference or psychology—consumers might like the feeling of independence and autonomy that comes along with ownership.

Autonomy carries real practical benefits. You can paint butterflies on your own car but not a rental. You can knock down walls in your own home. In Norway, customers of the Internet service provider Lyse are choosing to dig up their front yards and bury the fiber themselves, because they prefer to "arrange things just the way they want," rather than letting Lyse run fiber from the street to their door.[103] In the context of owning a broadband connection that runs all the way to an Open PoP, customers could benefit from greater choice and competition among information service providers, which could lead to the introduction of novel services.[104]

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[102] CONSUMER FTTH AND BROADBAND SURVEY, *supra* note 71.

[103] Nate Anderson, *Norwegian ISP: Dig Your Own Fiber Trench, Save $400*, ARS TECHNICA, May 11, 2009, http://arstechnica.com/tech-policy/news/2009/05/norwegian-isp-dig-your-own-fiber-trench-save-400.ars; *see also* Carol Wilson, *NAB: FTTH Provider's Customers Bury Their Own Fiber*, TELEPHONY ONLINE, Apr. 21, 2009, http://telephonyonline.com/residential_services/news/lyse-tele-burying-fiber-cable-0421/.

[104] As discussed above, with lower barriers to entry, this model may enable more service providers to enter the market. The possible benefits here are comparable to those enabled by

For non-early adopters, we should also consider that consumers often purchase products because, over the life of the product, they expect that it will be far cheaper to do so. If you drive every day, renting a car for seven years would most likely cost more than buying it.

Consumers might also save money in the broadband context—consider a lease-to-own plan offered by a carrier. Consumers may be able to use the money they already spend on Internet connections to fund eventual ownership of the fiber. Eventually, the consumers would be paying only for service—similar to a corkage fee at a restaurant where you can bring your own wine—and enjoying a discount for, in effect, bringing their own pipe. In addition, greater competition among service providers may lead to lower service prices.

The final reason that consumers might buy fiber has to do with the fact that the owner enjoys any appreciation in the property. If you buy land for $75,000, improve it, and later sell it for one–million dollars, you keep the difference. Fiber is akin to a type of home improvement or fixture, like a new kitchen, a patio, or oak floors—that is, an improvement that can contribute to the value of the home. A fiber connection could increase the resale value or rental value to a degree that could help justify the initial investment, particularly if the price of the investment is not very expensive. In another RVA survey conducted in 2008, home buyers and developers estimated that a fiber connection increases the value of a home by over $4,000.[105]

Related to this last point is the role of government incentives, which may provide another reason for consumers to purchase property. The most obvious example of this is the American home mortgage deduction.[106] Governments might provide incentives for consumers to have a particular interest in purchasing fiber, as we will discuss more below.

"open access" policies. However, there is an important distinction here—the benefits are created by a system of private property, rather than government regulation of network operators. *See* BERKMAN CENTER REPORT, *supra* note 9, at 77–80; Richard S. Whitt, *A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model*, 56 FED. COMM. L. J. 587, 631–32 (2004) (discussing how consumer-grade DSL services were created by independent competitors—not incumbents—and that "recent history shows that much of that innovation comes not from established incumbents guarding legacy market positions, but from hungry, eager competitors.").

[105] FTTH COUNCIL, FIBER TO THE HOME: ADVANTAGES OF OPTICAL ACCESS 18 (2009), *available at* http://broadbandpropertiesmagazine.epubxpress.com/ (follow "2009 FTTH Primer Tab"). It is true that a consumer could wait for a carrier to roll out fiber and the home would still increase in value. However, consumers might be eager to proactively buy connections in order to add this value to their homes.

[106] *See* I.R.C. § 163(h)(3) (2006).

IV. THE OTTAWA EXPERIMENT

The best way to test the practicalities of this proposed model and assess the degree of consumer interest is to experiment with actual implementations. In 2008, a 400-home, customer owned network began being built in downtown Ottawa, Canada.[107] Trunk fiber and splice points for the distribution of strands down individual streets have already been deployed.[108]

The experiment is spearheaded by Bill St. Arnaud, Chief Research Officer of CANARIE, a nonprofit group devoted to advanced network research in Canada. St. Arnaud has been promoting the customer-owned network model for over a decade and is now attempting to demonstrate the general business case for it. To accomplish this task, St. Arnaud came up with an inventive idea: selling fiber as part of a joint partnership between a specialized construction company named P2P Fibre Systems and electricity resellers.[109] In Canada, electricity resellers purchase power from wholesale providers and sell directly to customers.[110] To differentiate themselves, they offer packages that might, for example, sell electricity together with cheap long distance telephone service.[111]

St. Arnaud's idea was to sell cheap electricity and fiber together. The electric company sells the fiber connection along with its electricity contract, and collects payments over five years for it, through electricity charges of around two cents/kwh.[112] St. Arnaud calls this approach "green broadband" because the surcharge also creates an incentive to reduce energy usage.[113] In order to test out this concept, St. Arnaud picked a neighborhood that made deployment especially cost-effective.[114] P2P Fibre Systems estimates that a fifty percent take-up will generate a per-customer cost of around $1,100.[115] If only ten percent sign up, a conservative estimate of the per-customer cost is $2,700.[116]

In a survey of 100 homes, CANARIE found that thirty percent of customers

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[107] This description is based on several e-mail and phone interviews with Bill St. Arnaud during June-August 2008 (on file with authors) [hereinafter St. Arnaud interviews]. *See also*, St. Arnaud, *supra* note 8.

[108] *Id*.

[109] *Id*. *See also* Masha Zager, *Pilot Project: Customer-Owner Fiber in Ottawa*, BROADBAND PROPERTIES, Oct. 2008, at 19 *available at* http://www.bbpmag.com/2008issues/oct08/BBP_Oct08_Deployments.pdf.

[110] See Centre for Energy, Electricity Distribution in Canada, http://www.centreforenergy.com/AboutEnergy/Electricity/distribution/overview.asp?page=8 (last visited Nov. 5, 2009).

[111] St. Arnaud interviews *supra* note 107; Zager, *supra* note 109, at 19.

[112] St. Arnaud interviews *supra* note 107.

[113] *Id*.

[114] *Id*.

[115] *Id*.

[116] *Id*.; *see also* Zager, *supra* note 109, at 19 (noting that Arnaud suggests the break-even point could be as low as ten percent of customers).

were interested in signing up for this service.[117] Interestingly, some respondents even indicated more interest in purchasing the fiber connection outright.[118] CANARIE's business plan is based on a ten percent minimum homeowner take-up rate; in other words, before they run fiber down a particular street, they need ten percent of homes to sign up for the green broadband plan.[119]

What can we learn from the Ottawa experiment? Obviously, its success or failure is not a good predictor of what consumers would do at different price points. However, it can help indicate whether consumers can understand, and are interested in, the idea of paying for fiber. It can also indicate the usefulness of the bundling approach.

Interestingly, CANARIE's biggest challenge so far has not been getting consumers to sign up, but rather getting service providers on board.[120] Like the United States, the independent ISP market in Canada has drastically shrunk in recent years.[121] Despite an "open access" regime that allows independent ISPs to use incumbents' existing wires to provide broadband, the incumbent telephone and cable companies have the vast majority of the consumer market.[122]

In addition, incumbent carriers have an advantage because they dominate the cable television market and entry by independent ISPs may be difficult.[123] The incumbents are able to offer bundled "triple play" services that are cheaper for consumers than buying cable, Internet, and telephone service separately.[124]

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[117] St. Arnaud interviews *supra* note 107; Zager, *supra* note 109, at 19.

[118] Zager, *supra* note 109, at 19.

[119] *See id*.

[120] Jason Rodham, *Ottawa Fibre-To-The-Home Experiment Hits a Snag*, TECH MEDIA REPORTS, Aug. 5, 2008, http://www.techmediareports.ca/reports/content/ottawa_fibre_to_the_home_experiment_hits_a_snag.

[121] HEATHER ARCHIBALD, STRUGGLING TO REMAIN COMPETITIVE: A STUDY OF FACTORS IMPEDING GROWTH FOR CANADIAN INTERNET SERVICE PROVIDERS 2, 5 (2003), *available at* http://www.statcan.gc.ca/pub/63f0002x/63f0002x2003044-eng.pdf; Canadian Radio-television and Telecomm. Comm'n, *Communications Monitoring Report* (2008), tbl. 5.3.2., http://crtc.gc.ca/Eng/publications/reports/PolicyMonitoring/2008/cmr2008.htm (showing that in 2007 only four and a half percent of residential Internet subscribers in Canada received high-speed Internet service from a non-incumbent service provider).

[122] Canadian Radio-television and Telecomm. Comm'n, *Communications Monitoring Report* 2008, tbl. 5.3.2., http://crtc.gc.ca/Eng/publications/reports/PolicyMonitoring/2008/cmr2008.htm.

[123] Theresa Tedesco & Jamie Sturgeon, *Cable Rivals Drop Gloves*, FINANCIAL POST, Oct. 31, 2009, http://www.financialpost.com/story.html?id=2166052. Also, the CRTC regulates licensing of cable television services in various ways. *See* Rodham, *supra* note 120 (quoting Arnaud and discussing difficulty offering TV service); Canadian Radio-television and Telecommunications Commission, New Cable (Regional Licence) or Cable Renewal (Individual Licence), http://www.crtc.gc.ca/eng/forms/reldocs/reldoc136.htm (last visited Nov. 16, 2009).

[124] *See* Catherine McLean, *Cable Firms Seen Pushing Deeper Into Phone Market*, THE GLOBE AND MAIL.COM, Jan. 30, 2007,

Finally, the incumbents enjoy the twin advantages of recognized branding and large marketing budgets.

In time, independent ISPs may begin to fill the market. Fiber's higher speeds may become a large enough incentive itself for customers to sign up despite the lack of cable television, especially as online video services continue to grow as a substitute for traditional television service.[125] In addition, the market may be especially appealing to large, established incumbents from other areas of Canada that do not currently have a presence in Ottawa. Currently though, the lack of independent ISPs remains a substantial impediment to widespread adoption.

V. GOVERNMENT'S POTENTIAL ROLE

We have so far simply described the model of customer-owned fiber as an idea that private groups and local governments should investigate further. Local or national governments may also want to stimulate investment through other means.

One example of a government investment stimulus would be to provide financial incentives to carriers or other fiber providers. For example, governments could give tax breaks to carriers if they deploy multiple strands of fiber to a home, sell one or more strands to the homeowner, and enable the homeowner to connect those strands to competing service providers.[126] Once a carrier is already digging up the streets to run one strand of fiber to a home to sell their own services, the cost of running a second or third strand is relatively small. As such, a "home with tails" tax incentive would not impose much burden on carriers, and in fact, could be nearly pure profit.[127]

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http://www.theglobeandmail.com/news/technology/article739046.ece.

[125] CHANGEWAVE RESEARCH, BABY BOOMER PROFESSIONALS: INTERNET & TV VIEWING SURVEY 2 (2009), http://www.changewave.com/assets/alliance/reports/boomer_tv_20090602/boomer_tv_20090602.pdf [hereinafter INTERNET & TV VIEWING SURVEY] (surveying 1,660 people from forty-five to sixty-three years old and noting that more "than two-thirds of [them] . . . say they have watched video content on their computer over the past 90 days.").

[126] S. DEREK TURNER, FREE PRESS, DOWN PAYMENT ON OUR DIGITAL FUTURE: STIMULUS POLICIES FOR THE 21ST-CENTURY ECONOMY 19–20 (2008), http://www.freepress.net/files/DownPayment_DigitalFuture.pdf (proposing this idea).

[127] Some network operators believe that laying multiple fibers per home is economical as well as a useful business strategy. In deploying its new fiber to the home network, Swisscomm has decided to deploy multiple strands per home, noting that "[w]hile laying several fibres per household entails marginally higher investments, it guarantees competition at the technology and service levels. Limiting fibres to one per household would be impractical, since this would endanger the dynamic nature of the market and the technological innovativeness of the telecommunications industry over the next 30 to 50 years." Press Release, Swisscom, Into the Fiber-Optic Future with "Fibre Swisse" (Dec. 9, 2008), *available at* http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2008/20081209_01_M

Governments could also target incentives at consumers themselves, just as is done with other forms of infrastructure. For example, the home mortgage deduction in the United States encourages Americans to buy residential real estate, and thereby subsidizes the building of infrastructure, in this case, homes.[128] In recent years, Congress has also enacted more specific incentives for home improvement in ways perceived to be of general benefit. The Energy Policy Act of 2005 is a leading example of this targeted incentive, which aims to spur Americans to invest in energy efficient products and renewable sources of energy.[129]

These tax credits are designed not just with the consumer in mind, but with economic spillovers, or externalities, as well.[130] A home that relies on solar power, for example, saves money not just for the homeowner, but also decreases the costs imposed on others through pollution or the creation of greenhouse gases.[131] Hence, a solar power tax credit has stronger justifications than, say, a tax credit on the purchase of engagement diamonds.

Significant spillovers come from broadband deployment, and thus the tax credit model may be a suitable model for encouraging broadband investment, provided that a market for purchasing last-mile connections develops.[132] Consider, for example, a maximum $1,000 refundable tax credit for any homeowner who purchases property rights in a last-mile broadband connection. The credit would obviously encourage more purchases of such connections than we would expect to see otherwise.

Such an incentive would be a significant government expenditure, especially if successful. But compared to other ways of supporting broadband connectivity, the tax credit model may prove highly efficient. First, the tax credit model has fewer enforcement problems compared to a model that directly subsidizes service providers to deploy broadband services. Subsidy programs create the potential for money to be collected without the industry actually taking the actions they were subsidized to do. Second, this tax credit would support local decision-making in the spending of government money. Consumers would be deciding to purchase last-mile connections based on their own needs, as opposed to the sense of a central planner.

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it_fibre_suisse_in_die_Glasfaserzukunft.htm.

[128] I.R.C. § 163(h)(3).

[129] Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594. The Act gives tax credits to anyone who invests in energy efficient home improvements such as insulation, replacement windows, water heaters, and certain high efficiency heating and cooling equipment, solar energy systems, and fuel cells. *Id*.

[130] Lily L. Batchelder, Fred T. Goldberg, Jr., & Peter R. Orszag, *Efficiency and Tax Incentives: The Case for Refundable Tax Credits*, 59 STAN. L. REV. 23, 43–44 (2006).

[131] *See* GREG KATS, THE COSTS AND FINANCIAL BENEFITS OF GREEN BUILDINGS 19 (2003), *available at* http://www.usgbc.org/ShowFile.aspx?DocumentID=1992.

[132] *See* Atkinson, *supra* note 5, at 153–165; Whitt, *supra* note 28, at 457–461.

This point should not be exaggerated. Fiber providers would still have to make certain commitments for the program to succeed at all. They would, for example, have to incur the initial costs of running trunk fiber past many homes that do not sign up, in order to reach the early adopters that do wish to purchase fiber connectivity. We simply offer the consumer tax credit as an alternative way to spur adoption.

VI. CONCLUSION

Throughout this Article we have tried to be frank about the challenges and problems facing a consumer ownership model. In this conclusion, we come back to two possible objections suggested at the outset.

One objection might be that the fiber purchases we have described will primarily have meaning for the wealthy—homeowners for whom buying a last-mile connection is nothing compared to the price of high quality patio furniture. The point is well taken. Our principal answer is that what we describe here is not an exclusive means of encouraging broadband deployment. It can be combined with programs that are specifically targeted to poor or underserved groups. In addition, if there are homeowners who have the money for this type of home improvement, it makes sense to take advantage of that fact.

A second, very reasonable objection is that the industry simply would not sell, or that consumers will not buy, last-mile broadband connections—in other words, this model is simply too strange. Our only answer to this objection is that no Article can address that question by itself. This Article outlines how the customer ownership model could practically and technically function, and why it might be desirable and beneficial. The feasibility can only be borne out through further study and experimentation.

At the same time, we do contend that there is no fundamental reason that last-mile broadband cannot be sold to customers. There are many industries that have gone from service only industries to selling a product only, or a combined product and service. “Homes with Tails” might seem strange now, but tomorrow may bring unforeseen changes.